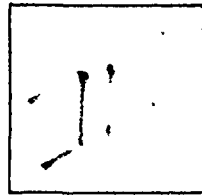


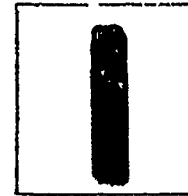
PHOTOGRAPH THIS SHEET

ADA 078562

DTIC ACCESSION NUMBER



LEVEL



INVENTORY

Fallout Patterns From Operation HARDTACK,
Phase II

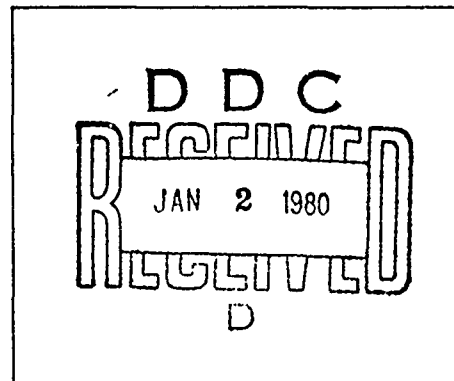
DISTRIBUTION STATEMENT A

Approved for public release;
Distribution Unlimited

DISTRIBUTION STATEMENT

ACCESSION FOR	
NTIS	GRA&I <input checked="" type="checkbox"/>
DTIC	TAB <input type="checkbox"/>
UNANNOUNCED	<input type="checkbox"/>
JUSTIFICATION	
Per Htr. on file	
BY	
DISTRIBUTION /	
AVAILABILITY CODES	
DIST	AVAIL AND/OR SPECIAL
A	

DISTRIBUTION STAMP



DATE ACCESSIONED

79 12 13 569

DATE RECEIVED IN DTIC

PHOTOGRAPH THIS SHEET AND RETURN TO DTIC-DDA-2

**Best
Available
Copy**

WB-LA-3

reviewed
by DOE/OC
7/5/79

UNITED STATES DEPARTMENT
WEATHER BUREAU

ADA 078562

FALLOUT PATTERNS FROM OPERATI

by

Kosta Telegadas and Kenneth
U. S. Weather Bureau, Washing

May 1960

Statement A
Approved for public release;
Distribution unlimited.

Prepared for

ALBUQUERQUE OPERATIONS OFFICE, U. S. AT

UNITED STATES DEPARTMENT OF COMMERCE

WEATHER BUREAU

DNA ✓
DOE ✓
FOI ✓

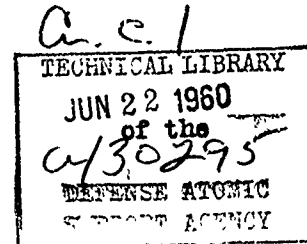
FROM OPERATION HARDTACK, PHASE II

#90

by

Telegadas and Kenneth M. Nagler
Weather Bureau, Washington, D. C.

May 1960



Prepared for

NS OFFICE, U. S. ATOMIC ENERGY COMMISSION.

SUMMARY OF BURST INFORMATION

BURST NUMBER	BURST NAME	YIELD	TIME	DATE	TYPE	BURST SITE
1	Otero	Some Nuclear Reaction	1300 PDT	12 SEP.	480' Deep Well	U-3q
2	Bernalillo	Minor Nuclear Reaction	1230	17	456' Deep Well	U-3n
3	Eddy	83 T	0700	19	500' Balloon	B-7b
4	Luna	Slight Nuclear Reaction	1200	21	484' Deep Well	U-3m
5	Mercury	Explosion Contained	1500	23	Tunnel	U-12f.
6	Valencia	Slight Nuclear Reaction	1300	26	484' Deep Well	U-3r
7	Mars	13 \pm 3 T	1700	27	Tunnel	U-12f.
8	Mora	2 KT	0605 PST	29	1500' Balloon	B-7b
9	Hidalgo	Low-level Nuclear Reaction	0610	5 OCT.	377' Balloon	B-7b
10	Colfax	Slight Nuclear Reaction	0815	5	350' Deep Well	U-3k
11	Tamalpais	72 \pm 10 T	1400	8	Tunnel	U-12b.
12	Quay	84 T	0630	10	100' Steel Tower	T-7c
13	Lea	1.5 KT	0520	13	1500' Balloon	B-7b
14	Neptune	90 \pm 20 T	1000	14	Tunnel	U-12c.
15	Hamilton	1.0 T	0800	15	50' Wooden Tower	T-F1
16	Logan	5.0 \pm 0.2 KT	2200	15	Tunnel	U-12e.
17	Dona Ana	36 T	0620	16	450' Balloon	B-7b
18	Vesta	Slight Nuclear Reaction	1500	17	Gravel Gertie	S-9e
19	Rio Arriba	92 T	0625	18	72 1/2' Wooden Tower	T-3s
20	San Juan	Non-nuclear Explosion	0630	20	234' Deep Well	U-3p
21	Socorro	6 KT	0530	22	1450' Balloon	B-7b
22	Wrangell	100 T	0850	22	1500' Balloon	B-Fa
23	Oberon	Non-nuclear Explosion	1230	22	25' Wooden Tower	T-8a
24	Rushmore	180 T	1540	22	500' Balloon	B-9a
25	Catron	Slight Nuclear Reaction	0700	24	72 1/2' Wooden Tower	T-3t
26	Juno	Slight Nuclear Reaction	0801	24	Gravel Gertie	S-9f
27	Ceres	Slight Nuclear Reaction	2000	25	25' Wooden Tower	T-8b
28	Sanford	4.5 KT	0220	26	1500' Balloon	B-Fa
29	De Baca	2.5 KT	0800	26	1500' Balloon	B-7b
30	Chaves	Slight Nuclear Reaction	0630	27	52 1/2' Wooden Tower	T-3u
31	Evans	55 \pm 30 T	1600	28	Tunnel	U-12b.
32	Mazama	0	0320	29	50' Steel Tower	T-9d
33	Humboldt	6 T	0645	29	25' Wooden Tower	T-3v
34	Santa Fe	1.25 KT	1900	29	1500' Balloon	B-7b
35	Ganymede	Non-nuclear Explosion	0300	30	Gravel Gertie	S-9g
36	Blanca	19 \pm 1.5 KT	0700	30	Tunnel	U-12e.
37	Titania	Slight Nuclear Reaction	1234	30	25' Wooden Tower	T-8c

BURST INFORMATION

TYPE	BURST SITE	ELEVATION OF SITE	CLOUD TOP (MSL-FEET)	CLOUD BASE (MSL-FEET)	PAGE
op Well	U-3q	4035	9,000	-	12, 13
op Well	U-3n	4030	7,500	5,500	15
alloon	B-7b	4186	11,000	7,500	16, 17
op Well	U-3m	4031	Low Diffuse Cloud	-	18
	U-12f.01	6720	None	-	5
op Well	U-3r	4033	5,500	-	19
	U-12f.02	6720	Low Diffuse Cloud	-	21
alloon	B-7b	4186	18,500	10,000	22, 23
alloon	B-7b	4186	12,000	8,000	24, 25
op Well	U-3k	4033	5,500	4,500	26
	U-12b.02	6650	Low Diffuse Cloud	-	27
el Tower	T-7c	4249	10,000	7,500	29, 30, 31
alloon	B-7b	4186	17,000	12,000	32, 33
	U-12c.03	6800	11,000	-	35
en Tower	T-F1	3080	6,000	4,500	36, 37
	U-12e.02	6140	None	-	5
alloon	B-7b	4186	11,000	6,500	38, 39
ertie	S-9e	4226	10,000	-	40, 41
Wooden Tower	T-3s	4010	13,500	11,000	42, 43
op Well	U-3p	4033	None	-	6
alloon	B-7b	4186	26,000	20,000	45, 47
alloon	B-Fa	3077	10,000	7,000	46, 47
en Tower	T-8a	4446	Very Low	-	6
alloon	B-9a	4214	11,500	-	45
Wooden Tower	T-3t	4018	8,500	5,000	48, 49
ertie	S-9f	4210	5,500	-	50
en Tower	T-8b	4428	6,000	-	51
alloon	B-Fa	3077	26,000	12,500	53, 55
alloon	B-7b	4186	17,500	10,000	54, 55
Wooden Tower	T-3u	4025	6,500	-	56, 57
	U-12b.04	6650	No Organized Cloud	-	59
al Tower	T-9d	4202	6,500	-	6
en Tower	T-3v	4029	7,500	6,000	60, 61
alloon	B-7b	4186	18,000	13,000	62, 63
ertie	S-9g	4193	Very Low	-	6
	U-12e.05	7120	7,700	-	64, 65, 66
en Tower	T-8c	4403	6,000	-	67

EXPLANATION OF TABLE

Column 3, Yield:	<ul style="list-style-type: none">a. T indicates ton equivalent of TNT.b. KT indicates kiloton equivalent of TNT.c. The yields for tunnel detonations are from the unclassified memorandum, "Total Yields of Underground Events-Hardtack II", Lawrence Radiation Laboratory, Livermore, California, June 23, 1959, and fromd. Johnson, G.W. et al., "Underground Nuclear Detonations". Journal of Geophysical Research, Vol. 64, No. 10, October 1959, pp. 1457-1470.e. Other yields are from "AEC Releases Data on Hardtack Bomb Tests". U.S.A.E.C., Washington, D.C., March 10, 1959.f. The Office of Test Information, Nevada Test Site Organization, Las Vegas, Nevada, issued news reports on the yield or containment of explosions. The original language from these reports was included wherever a yield was not given.
Column 4, Time:	PST - Pacific Standard Time; PDT - Pacific Daylight Time.
Column 6, Type:	<ul style="list-style-type: none">a. For deep-well shots all devices were placed at various depths in 500-foot wells, with the exception of the San Juan event which was in a 250-foot well.b. Gravel Gertie denotes a surface shot detonated in a small wooden building covered with about 20 feet of gravel.
Column 7, Burst Site:	Each burst site is denoted by (1), a capital letter designating the type of shot (i.e., B for balloon, S for surface, T for tower, and U for underground); (2), a number indicating the area in which the burst occurred; and (3), a small letter identifying the location in the area.
Column 8, Elevation of Site:	For balloon or tower bursts-the height above sea level of the earth's surface below the device; for underground bursts-the elevation at which venting occurred or, when there was no venting, the elevation of the device.
Column 9, Cloud Top:	Height of the cloud top above mean sea level, in feet. There is some uncertainty as to the values presented here since they were primarily visual aircraft reports and since the reports were not always made at the time of cloud stabilization.
Column 10, Cloud Base:	Height of the top of the stem (or base of the mushroom head) above mean sea level, in feet. There is considerable more uncertainty as to these numbers than for the cloud tops. Besides the uncertainty in the visual aircraft reports and cloud stabilization time, there is also the uncertainty as to the height of the base since in many cases the base was not too well defined. For some events the height of the cloud base was not reported.
Column 11, Page:	Pages on which maps or discussions of the bursts appear.

UNITED STATES DEPARTMENT OF COMMERCE

WEATHER BUREAU

FALLOUT PATTERNS FROM OPERATION HARDTACK, PHASE II

by

Kosta Telegadas and Kenneth M. Nagler
U. S. Weather Bureau, Washington, D. C.

MAY 1960

Prepared For
THE ALBUQUERQUE OPERATIONS OFFICE, U.S. ATOMIC ENERGY COMMISSION

INTRODUCTION

The Hardtack, Phase II, nuclear test operation differed from previous series in the great number of nuclear and safety devices detonated within a fairly brief period, in the very low yields of many of the detonations, and in the variety of burst conditions. Basic information on the various bursts is summarized on the inside of the front cover. Orientation maps of the Nevada Test Site region, and of the Nevada Test Site itself are shown on the inside of the back cover.

As far as public safety is concerned, radiation from Hardtack, Phase II, was even less important than that from most previous Nevada test operations. However, since low levels of activity are fairly difficult to detect, the documentation of such fallout that did occur was comparatively difficult. The radiation from passing airborne radioactive clouds was relatively more important than in previous test series because of the many low nuclear cloud heights. There were also problems concerning decay rates and the arrival times of the fallout.

The purpose of this report is to present and discuss the fallout patterns from Operation Hardtack, Phase II. Although there are many uncertainties in the analysis of the fallout data, careful consideration has been given to all available monitoring and wind information in an attempt to depict as well as possible the actual fallout patterns.

Similar patterns from past Nevada operations are given in References 1 and 2.

SOURCES OF DATA

Off Site

The fallout documentation for purposes of public safety outside the test site was performed by the Off-Site Radiation Safety Organization (staffed by the U.S. Public Health Service). Their monitoring information is for the most part contained in the "Off-Site Radiological Safety Report for Operation Hardtack, Phase II", (3), which contains dose-rate and dose information for selected points, ground monitors' survey summaries, and measurements of the concentration of radioactivity in the air at a number of communities. Measurements of airborne alpha activity appear in the "Alpha Air Sampling Report" (4). The monitors' original logs were also of use, as they often contain useful information as to background radiation or as to very low activities observed but not reported in the summaries.

On Site

The fallout documentation for purposes of personnel safety within the test site was performed by the On-Site Radiological Safety Organization (staffed by the Reynolds Electrical and Engineering Company). Their monitoring information appears in several sources: 1, the monitors' original logs; 2, reports of special surveys performed for the Fallout Prediction Unit; and 3, maps of the dose-rate field based on the results of each survey. These maps appear in the "On-Site Radiological Safety Report for Operation Hardtack, Phase II", (5).

On many occasions talks with the monitors proved helpful in the analysis of the data. Also, the special surveys made for the Fallout Prediction Unit by both of the Off-Site and On-Site groups were useful in delineating the fallout from some of the bursts.

DECAY RATES

Since the monitor readings of dose rate were made at various times after the detonation, these measurements had to be adjusted to a common reference time to permit analysis of the data. The available information from which decay rates could be derived was examined for each of the various different types of detonations, that is, for balloon, tower, surface, deep well, and tunnel shots. However, the only available information as to decay rates was

that derivable from the routine monitoring data. As would be expected in the absence of a specific program to study decay rates, the pertinent data are limited and the determination of decay rates can only be approximate.

A major source of error is the uncertainty as to whether the measurements taken along a particular route at different times were taken at precisely the same location. To minimize this error, only the measurements at specifically-designated locations were considered, and even for such locations this position error cannot be eliminated altogether. It normally is greatest where the gradient of activity is strongest.

The available data are shown in graphical form in figures 1-3. Figure 1 shows the decay curves for radiation from balloon detonations close to ground zero, where neutron-induced radioactivity is logically significant. As has previously been observed by the On-Site Rad-Safety group, the dominant constituent of this induced activity, except at early times when manganese-56 is important, appears to be sodium-24, which has a half life of about 15 hours. This decay rate and the $t^{-1.2}$ approximation of gross fission-product decay are shown. From figure 1 it can be seen that the sodium decay better approximates the observed decay of the close-in radiation from balloon bursts than does the gross fission-product decay. For simplicity, the sodium-24 decay rate was used to adjust the close-in radiation measurements from balloon shots to a common reference time.

Figures 2 and 3 show the data available for assessing decay rates for the deep-well, tower, and surface detonations. The sodium-24 and $t^{-1.2}$ decay curves are included for reference. The $t^{-1.2}$ approximation seems reasonable for these shots, and, for lack of better information, was also used for the tunnel bursts and for all off-site fallout. Again, it should be pointed out that the decay rates used are only approximate.

RADIATION FROM PASSING NUCLEAR CLOUDS

Some of the early dose-rate measurements show the effect of radiation from passing nuclear clouds. This radiation, sometimes called shine or sky shine, may come from a nuclear cloud many thousands of feet or perhaps a few hundred feet above ground, or it may come from nuclear debris in the air right at the ground level. Because of the nearness of the radiation source, the shine from a low-level cloud is normally more apparent than that from a high cloud even though the radiation in the higher cloud may be several orders of magnitude greater than that in the cloud near the ground.

Figures 4 and 5 show the early dose-rate measurements at several locations from several of the bursts. Typically, the dose rate shows a rapid rise and then a rapid decline, but there may be subsequent fluctuations as other parts of the nuclear cloud pass by. Later there is a gradual decrease of dose rate, which results from the decay of the true fallout.

It is of interest to compare the contribution from the shine to that from the true fallout. The total dose accumulated during any period is indicated by the area under the dose-rate curve for that period. To obtain the infinite dose an extrapolation was made beyond the last measurement by means of the $t^{-1.2}$ decay law. In order to get a rough estimate of the fallout part it was assumed that the true fallout began to arrive when radiation above background was first detected and that the dose rate increased linearly up to the time when fallout had ceased and there appeared to be no further effect of shine, that is, up to the time when the decrease in the dose rate seemed to be governed by the typical gross fission-product decay.

From the estimates of the total infinite dose and the infinite dose from true fallout only, an estimate of the contribution to the dose from shine can be made.

In the case of radiation at Mercury from the Hamilton burst it was estimated that the dose from the transient debris was about the same as the infinite dose from the true fallout, namely about 8 mr from each source. For the other cases depicted in figures 4 and 5, the dose from shine was also about as large as or greater than that from true fallout.

It might be pointed out here that if the high reading (at Mercury from Hamilton) of 11 mr/hr at H+1.8 hours was assumed to be exclusively from fallout and was extrapolated from H+1.8 hours to infinity by means of the $t^{-1.2}$ law, a fictitious infinite dose of nearly 100 mr would result.

ALPHA CONTAMINATION

Monitoring reports from a few of the bursts indicated that there was no gamma fallout but that there was some alpha contamination on the ground close to the burst sites. Also, there were a few cases in which some alpha fallout was reported in addition to gamma fallout. No analysis of the alpha radiation has been included in this report; but the general areas of alpha contamination are shown in the On-Site Radiological Safety Report (5).

The off-site alpha activities (Reference 4) as well as the beta activities (Reference 3) frequently detected at the fixed air-sampling stations were used

as an indication of the general movement of fallout.

DISCUSSION OF FALLOUT MAPS

One or more fallout maps are given for each burst in the series, except for those from which there was no gamma radiation observed or from which there were too few reports of radiation to suggest any sort of pattern. The bursts for which no patterns are drawn are discussed on pages 5 and 6.

For most bursts maps of two scales are given: a large-scale map showing the very close-in fallout (termed Map A), and a smaller-scale map showing the more remote spread (Map B). For bursts from which only close-in fallout was reported only a large-scale map is given. For Quay and Blanca maps of three scales are included, identified as Maps A, B, and C. It should be noted that maps for different bursts are sometimes of different scales, even though they are indicated as being in the same category; e.g., Map A or Map B.

When there are two or three maps for one burst, they have been arranged so that two of them appear on facing pages - which accounts for the blank pages.

There is some variety in the format of the maps. For example, the terrain is indicated only on the small-scale maps. Also, on the small-scale maps only, those roads along which monitoring runs were made are shown as heavy lines. To avoid confusion not all of the monitored roads are shown on the large scale maps.

The coordinates shown on the large-scale maps are from the Nevada State Grid, which is a rectangular grid system based on a transverse Mercator projection. The coordinates are designated in feet.

The various items contained on the maps are discussed in the following sections.

Dose-rate contours. Dose-rate contours for the large-scale fallout patterns have been drawn for the gamma dose rate one hour after burst time. A few of the small-scale patterns were drawn for 12 hours after burst time, consistent with the procedure used in References 1 and 2; but because of the very low levels of radiation, most of the small-scale patterns are for H+1 hour.

As noted earlier, the $t^{-1.2}$ approximation was used to adjust radiation measurements to the appropriate reference times for all types of bursts, except for the close-in patterns from balloon bursts, for which the sodium-24 decay curve was used.

Each of the close-in patterns from the balloon bursts shows a closed 10 mr/hr contour, and on each small-scale pattern a secondary maximum appears. Between the two fallout areas it is not known whether there is very light fallout or no fallout at all. From Plumbbob data there is a suggestion that the pattern is continuous, but that the dose rates in the intermediate region were too low to be recorded by the on-site monitors, who normally were concerned only with dose-rates of 10 mr/hr or greater.

Where the patterns are based on nearby monitoring information, they are shown as solid lines; where there was a considerable interpolation or extrapolation, dashed lines are used.

The maximum dose rate. As a guide to the highest dose rates associated with the various types of detonations, an estimate has been given whenever possible of the highest dose rate observed, adjusted to the H+1 value by the appropriate decay scheme as discussed above. These estimates appear on the large-scale fallout maps. Often the maximum dose rate at H+1 was estimated from a dose-rate reading made in a survey a day or two after the burst, particularly when the readings were too high to permit routine monitoring near ground zero during the early surveys. In such a case errors in the assumed decay rate may lead to a fairly large error in the estimate of the H+1 dose rate. Also, there is sometimes the possibility of there having been a small area of greater activity than was detected. The maximum dose rate given can only be considered a rough guide to the approximate highest radiation level from each burst.

Time of arrival. Normally when fallout first arrives at any location, the dose-rate is rather small, but it increases as more fallout descends. While the fallout is accumulating (and possibly even before any true fallout arrives), there may temporarily be high dose rates due to passing airborne debris. In a few minutes or a few hours, depending on the nature of the explosion, the wind field, and the distance from the burst site, the fallout is essentially complete and the dose rate starts its steady decrease due to the decay of the fission products. Thus there is no precise time of arrival of the fallout. The time lines shown on the fallout maps are intended to give only rough average arrival times as estimated from the wind reports and the available monitoring information.

Trajectories. Meteorological trajectories for selected levels are included on the off-site fallout maps. Such a trajectory depicts the

path of gaseous or small-particle debris which has a negligible fall rate. The trajectories are all for constant heights above sea level except those marked, in a meteorological jargon, "trajectory at gradient wind level". The gradient wind, simply, is the wind at some level high enough above the general terrain so that the effects of friction of air with the earth are trivial. The gradient level trajectories in this report represent a height of about 3,500 feet above the ground and hence vary in height above sea level. As a rough average, however, this level is about 6,500 feet above sea level in the region of the test site.

The meteorological trajectories are based on the wind analyses for the various levels at three- or six-hour intervals, as provided by the Weather Bureau Research Station, Las Vegas, Nevada. They take into account the temporal and spatial changes in the wind. Meteorological trajectories are of course, subject to error, particularly over regions of sparse data, in areas of rapidly changing or complex flow patterns, and in regions where the wind speeds are very light. Even though there was a fairly dense network of stations reporting upper winds during the test period, significant uncertainties are sometimes present.

In general, however, the fallout patterns and the meteorological trajectories were in fairly good agreement. Such differences as do appear between the location of a trajectory and the location of the contaminated area may be due to errors in computing the trajectory; but normally they are due primarily to the fact that the deposition is a function of the winds at all levels below the nuclear cloud. Also, a great many of the Hardtack, Phase II, bursts resulted in low nuclear clouds. Such clouds may be subject to channelling or other effects of the terrain; or particularly during the daytime, they may be diffused upward and downward by turbulent mixing. A nuclear cloud from an early morning detonation, for example, may be such that most of the radioactivity is between 5,000 and 10,000 feet above the ground. The part of the material which does not have a significant fall rate would be moved by winds in this layer until daytime heating of the ground is sufficient to produce an unstable layer from the ground up to the radioactive levels. Then, there may be a mixing of the nuclear debris throughout the layer from the ground to the initial cloud height or even higher. Some small particles may then be brought close enough to the ground so that their otherwise trivial fall

21

rates may bring them to earth. Even particles with completely negligible fall rates may impinge upon and remain on the ground or on vegetation.

In addition to their use as a rough check on the locations of the fallout patterns, the trajectories were used as a guide in estimating times of arrival of the fallout.

Meteorological data. The most important pertinent meteorological information has been included on the fallout maps in order that it may be viewed along with the fallout estimates.

Curves of temperature and dew point versus height, as measured at the Yucca Lake Weather Station, are given. The temperature-height structure is useful in assessing the vertical stability of the atmosphere and plays a dominant role (along with weapon yield) in determining the height of a nuclear cloud.

The dew point distribution with height probably also plays a role in determining cloud height and is related to the amount of water in the nuclear cloud and hence to the appearance of the nuclear cloud. Levels for which the dew-point curve is missing are normally very dry.

The adiabatic lapse rate indicated on each sounding is that rate of temperature decrease with height which indicates neutral stability. When that lapse rate exists in the atmosphere, a parcel of air given some impetus upward or downward meets no opposition, other than friction, to its motion. Such a lapse rate is often accompanied by vertical mixing. When the temperature decreases more slowly with height than the adiabatic rate and, particularly when there is no decrease or even an increase with height, then the atmosphere is in a stable condition, since work must be done on any parcel of air to move it upward or downward. When the temperature decreases more rapidly than the adiabatic rate, which is an infrequent and temporary condition except near the ground on days with strong solar heating, the atmosphere is subject to rapid overturning and hence mixing throughout the unstable layer.

The most important meteorological factor in determining the distribution of the fallout is the wind field. For most bursts the upper-air shot-time winds are given for heights up to at least the top of the nuclear cloud. Directions are in degrees from which the wind is blowing; speeds are in knots. These winds were measured at the Yucca Lake Weather Station. In some cases, however, these winds may not be representative

of the winds at the place of detonation. This is especially true for the Area 12 tunnel shots, since the Yucca station is about 20 miles to the southeast and has an elevation of about 4,000 feet whereas the tunnels were above the 6,000-foot level on the slopes of a 7,500-foot mesa. When a nuclear cloud from this area extended higher than the mesa top, the part that extended above the mesa top was probably influenced by winds not very different from those measured at Yucca Lake, since the Weather Bureau Research Station at Las Vegas has found a high correlation between the wind direction on a meteorological tower on the mesa and the wind direction at the same elevation (about 7,500 feet above sea level) over Yucca Lake. For the majority of tunnel bursts from which venting occurred, however, the nuclear clouds were confined to very low heights where the winds were greatly influenced by local factors. The heating (or cooling) of the air near the slopes relative to that at similar elevations in the free air over the valleys leads to flow upslope in the daytime (or downslope during the night). Typically, the upslope winds start at about a half hour after sunrise and reverse their direction shortly before sunset. While the reversal is taking place the winds usually remain very light and variable for five or ten minutes.

When available, pertinent wind information from meteorological towers in Area 12 and Area 8 is included in the remarks accompanying the fallout maps.

Remarks. For each of the fallout maps comments are given on the analysis, and the uncertainties are discussed in order that the reliability of various parts of the pattern can be judged.

BURSTS FOR WHICH NO MAPS ARE GIVEN

No fallout maps are given for several of the bursts because there was a negligible yield or, in the case of underground bursts, because there was a trivial or no release of fission products into the atmosphere. These bursts are discussed individually below.

Mercury (Burst No. 5). Since there was essentially no nuclear yield from Mercury, no venting into the atmosphere was observed. There was, however, some alpha contamination in the main tunnel.

Logan (Burst No. 16). The Logan burst was completely contained and therefore no radiation from this explosion was released into the air.

San Juan (Burst No. 20). There was essentially no nuclear yield from the San Juan explosion and no visible venting occurred. There was, however, some alpha contamination detected in the immediate vicinity of the well in which this device was detonated.

Oberon (Burst No. 23). There was essentially no nuclear yield from Oberon and only a very low cloud was observed. No gamma activity was reported, but there was some alpha contamination around ground zero and a short distance down wind (toward the northwest).

Mazama (Burst No. 32). There was essentially no nuclear yield from Mazama and only alpha contamination was reported around ground zero. A visible cloud resulted from the Mazama explosion which was estimated from aircraft to reach somewhere between 5,000 and 6,500 feet above sea level (800 to 2,300 feet above ground). With the stable night-time atmosphere, no nuclear yield, and only a small amount of high explosive, it seems doubtful that the cloud could have reached higher than the lowest of the estimates. Perhaps the higher estimates resulted from the difficulty in estimating the height of a low, small cloud at night.

Ganymede (Burst No. 35). There was no nuclear yield for Ganymede. The cloud was very low, but the height could not be determined due to darkness. There was some alpha contamination in the immediate vicinity of ground zero.

ACKNOWLEDGMENTS

The authors wish to thank William Johnson, Floyd W. Wilcox, John Coogan, and the monitoring staff in the On-Site Radiological Safety Organization and Oliver R. Placak, Morgan Seal, and the monitors in the Off-Site Radiological Safety Organization for providing and aiding in the interpretation of monitoring information.

We thank Philip W. Allen, Meteorologist in Charge of the Weather Bureau Research Station in Las Vegas, and his associates for providing the required meteorological data.

Also, we appreciate the conscientious work of Mrs. Barbara Ritchie in drafting the many figures and maps in the report.

REFERENCES

1. Nagler, K. M. and Telegadas, K., Distribution of Significant Fallout from Nevada Tests. U. S. Weather Bureau, Washington, D. C., October 1956.
2. Shelton, A. V. et al., Fallout Patterns, Operation Plumbbob. (A report to the Test Manager for the Nevada Test Site by his Committee to Establish Fallout Doses and Intensities.), April 1, 1958.
3. Placak, O. R. et al., Off-Site Radiological Safety Report, Operation Hardtack, Phase II (OTO-58-6). Prepared by the Permanent Public Health Service Off-Site Activities Staff, Nevada Test Site Organization, Mercury, Nevada, 1958.
4. Placak, O. R., Alpha Air Sampling Report (a supplement to the Off-Site Radiological Safety Report (Reference 3, above)), March 5, 1959.
5. Reynolds Electrical and Engineering Company, Radiological Safety Division, On-Site Radiological Safety Report, Operation Hardtack, Phase II (OTO-58-5), 1959.

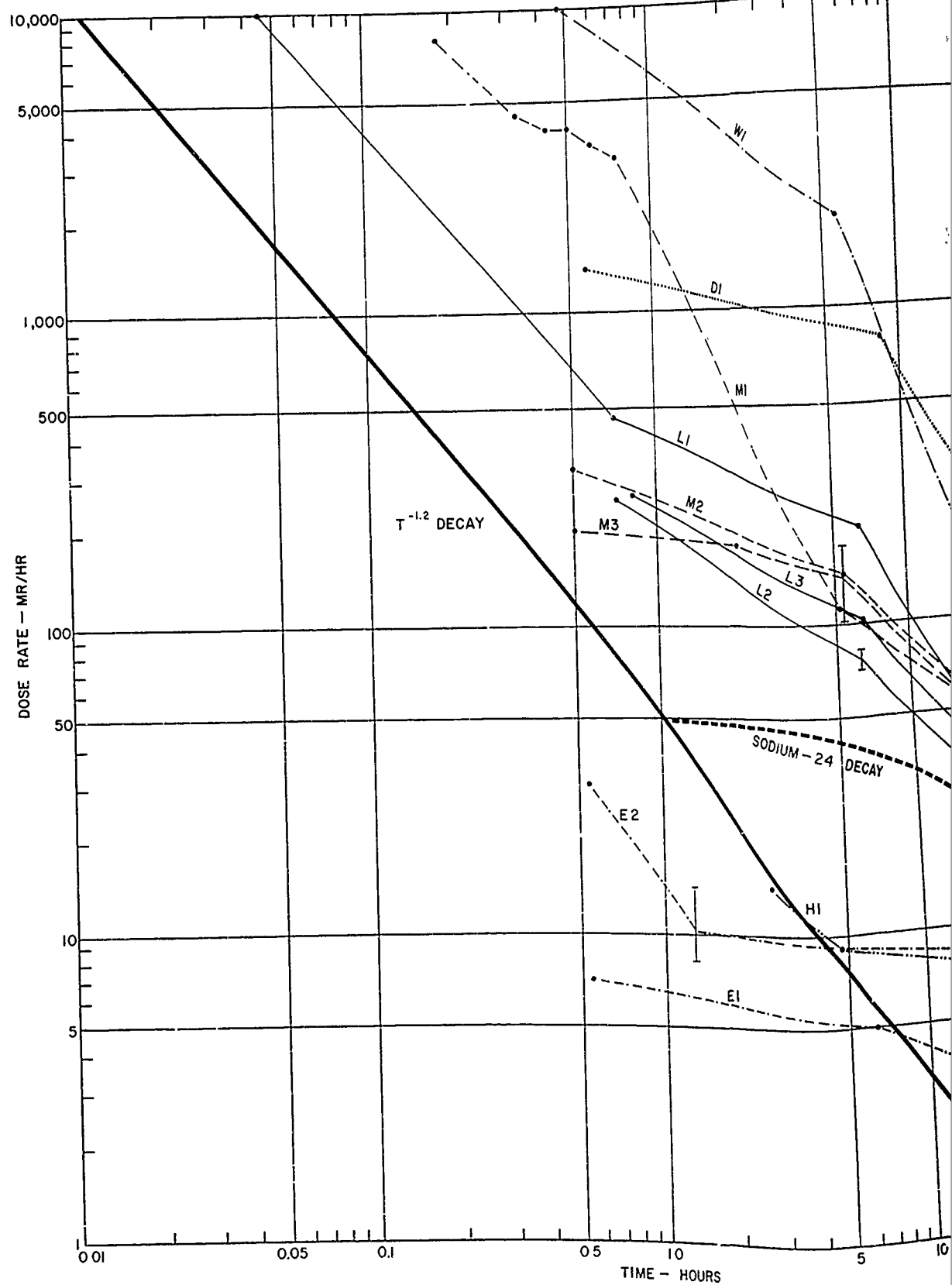
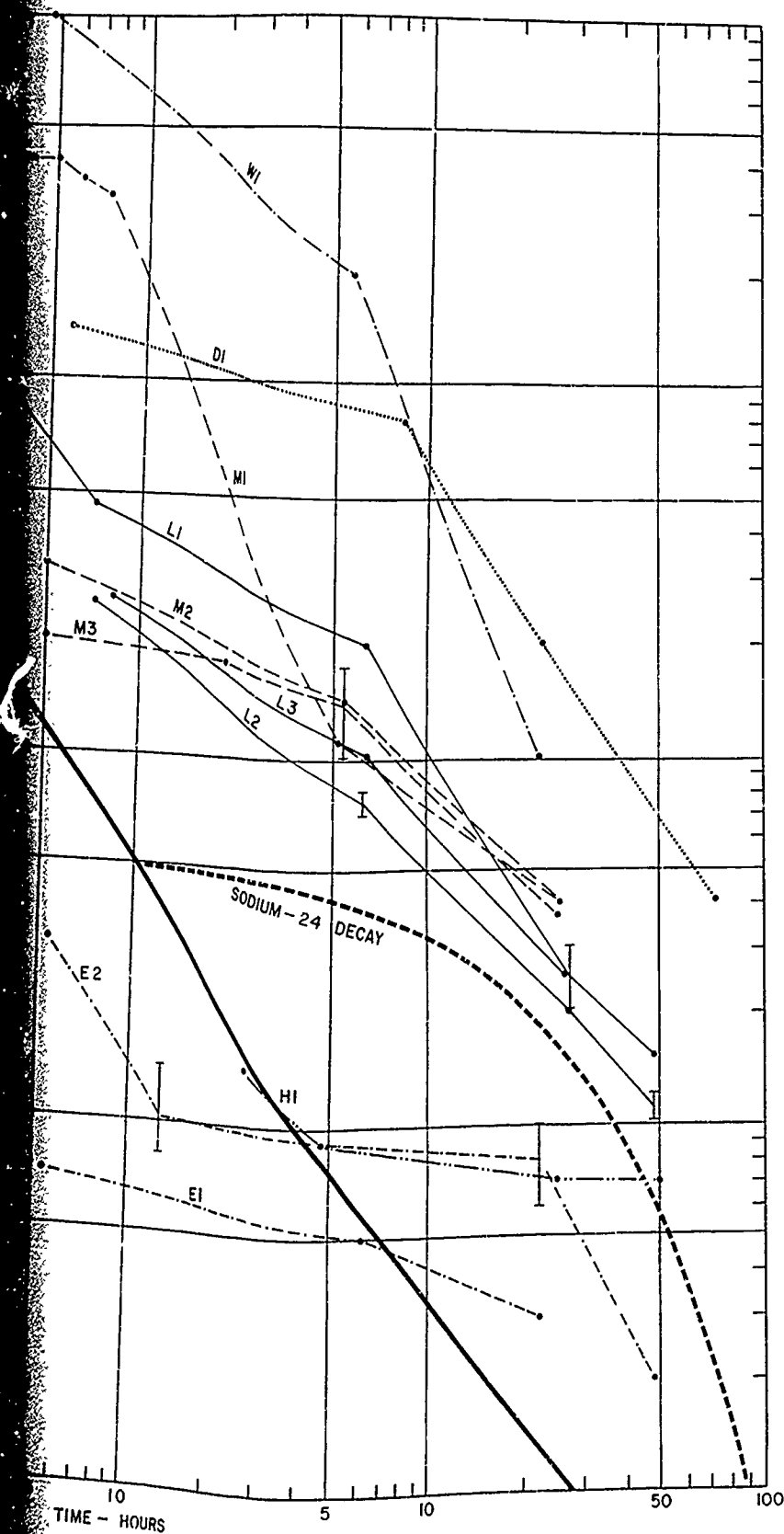


FIGURE 1 - DECAY CURVES FOR HARDTACK PHASE 2 BALLOON SHOTS FO



BURSTS AND MONITORING LOCATIONS

WRANGELL	-----
WI	Ground zero
EDDY	-----
E1	South winch site ~ 3000 ft. from G.Z.
E2	T-7c station ~ 3000 ft. from G.Z.
MORA	-----
M1	7-800 station ~ 3000 ft. from G.Z.
M2	Japanese houses ~ 3500 ft. from G.Z.
M3	T-7c station ~ 3000 ft. from G.Z.
LEA	-----
L1	7-800 station ~ 3000 ft. from G.Z.
L2	West winch site ~ 3000 ft. from G.Z.
L3	East winch site ~ 3000 ft. from G.Z.
DONA ANA	-----
DI	7-300 station ~ G.Z.
HIDALGO	-----
HI	T-7c station ~ 3000 ft. from G.Z.

┌ Indicates the range of dose
rates given

PHASE 2 BALLOON SHOTS FOR THE ON-SITE AREA.

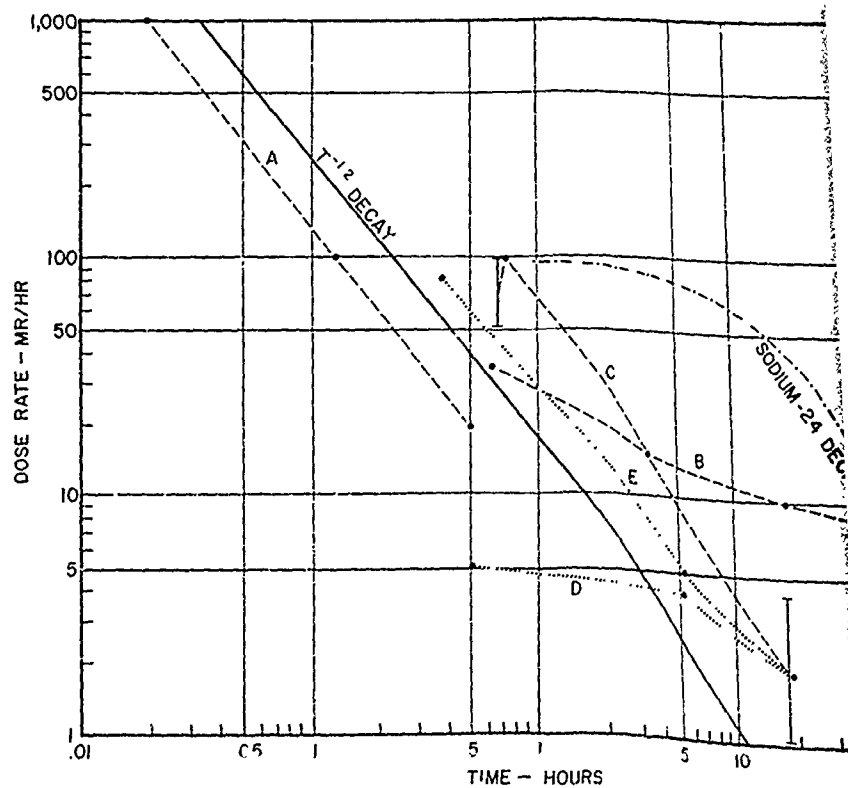
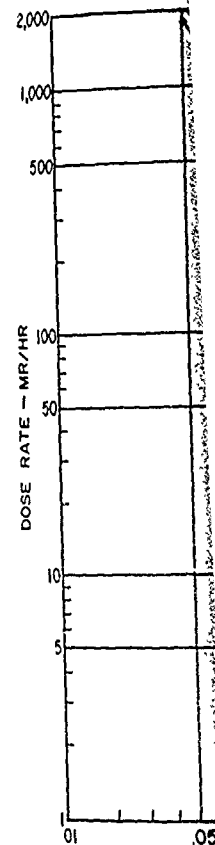
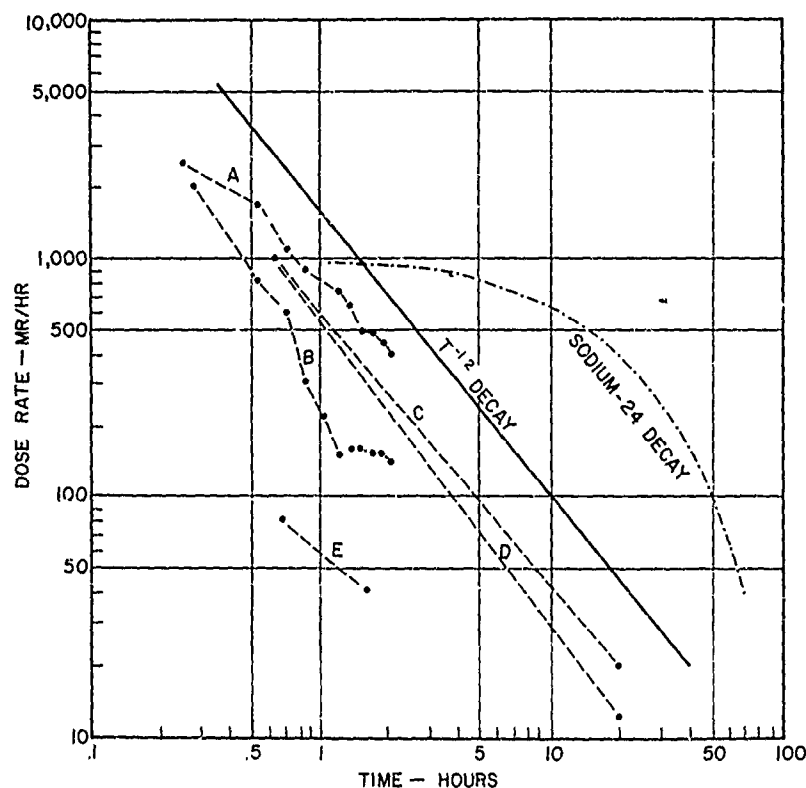
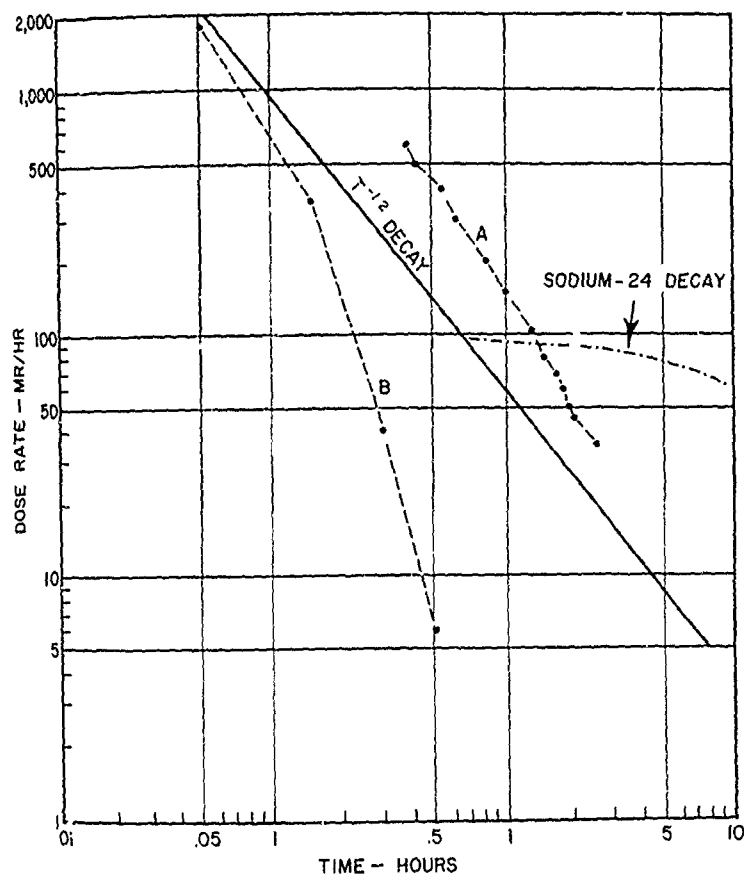
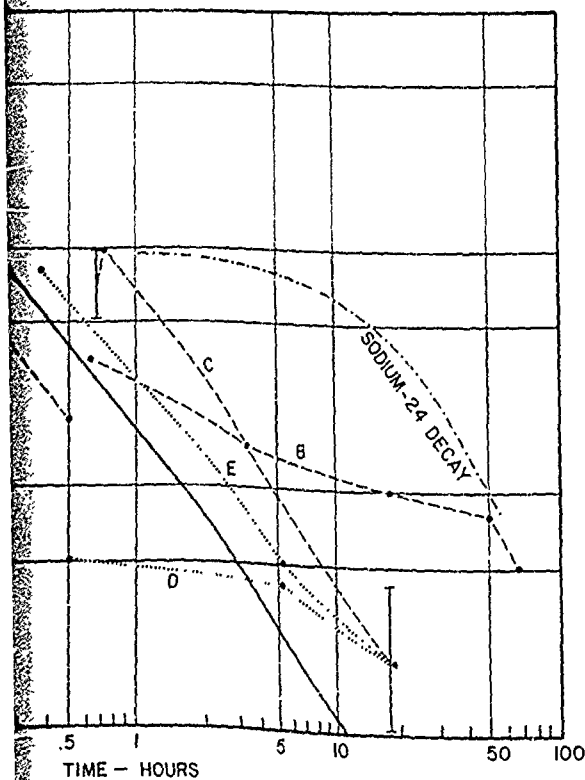


FIGURE 2—DECAY CURVES FOR HARDTACK PHASE 2 WELL SHOTS FOR T

WELL
 100 ft. from G.Z.
 100 ft. from G.Z.
 100 ft. from G.Z.
 100 ft. from G.Z.
 5 miles from G.Z.



--- COLFAX - 350 FT. WELL
 A RAM station ~ 300 ft. from G.Z.
 B Station 3-300 ~ 1000 ft. from G.Z.



--- BERNALILLO - 456 FT. WELL
 A RAM station ~ 800 ft. from G.Z.
 B Station U3r ~ 800 ft. from G.Z.
 C Station U3k ~ 500 ft. from G.Z.
 LUNA - 500 FT. WELL
 D Station U3r ~ 1000 ft. from G.Z.
 E Station U3k ~ 200 ft. from G.Z.

Indicates the range of dose rates given

PHASE 2 WELL SHOTS FOR THE ON-SITE AREA.

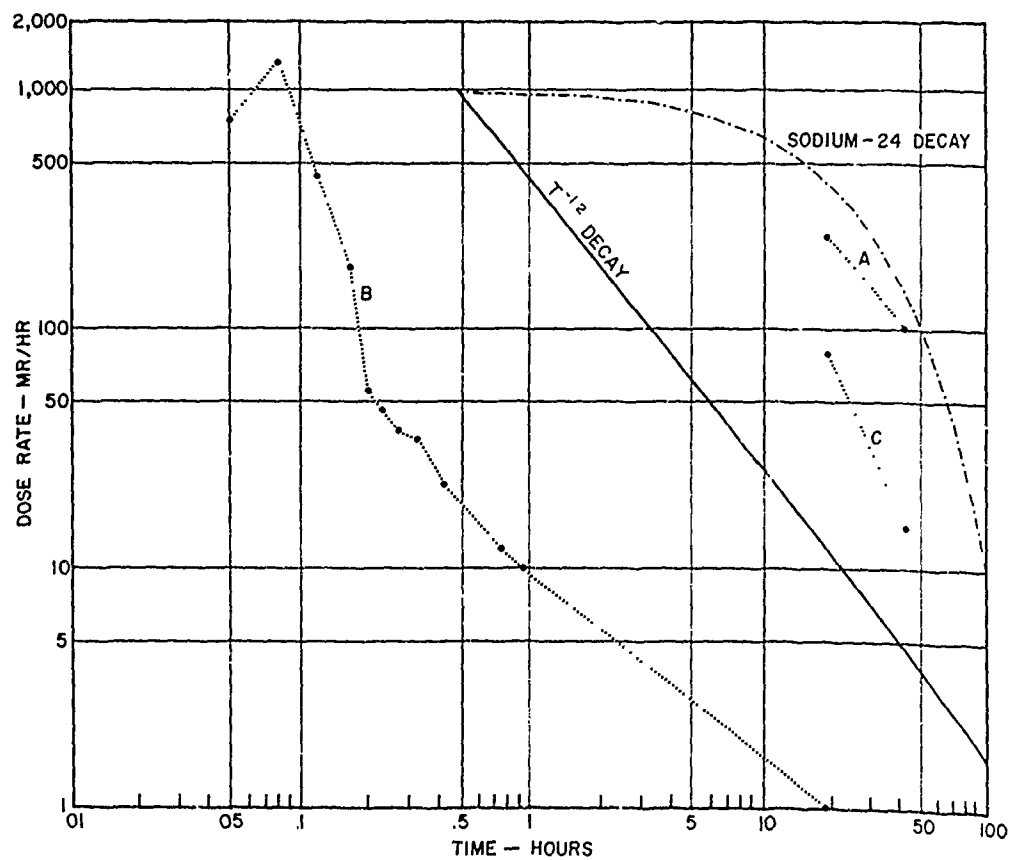
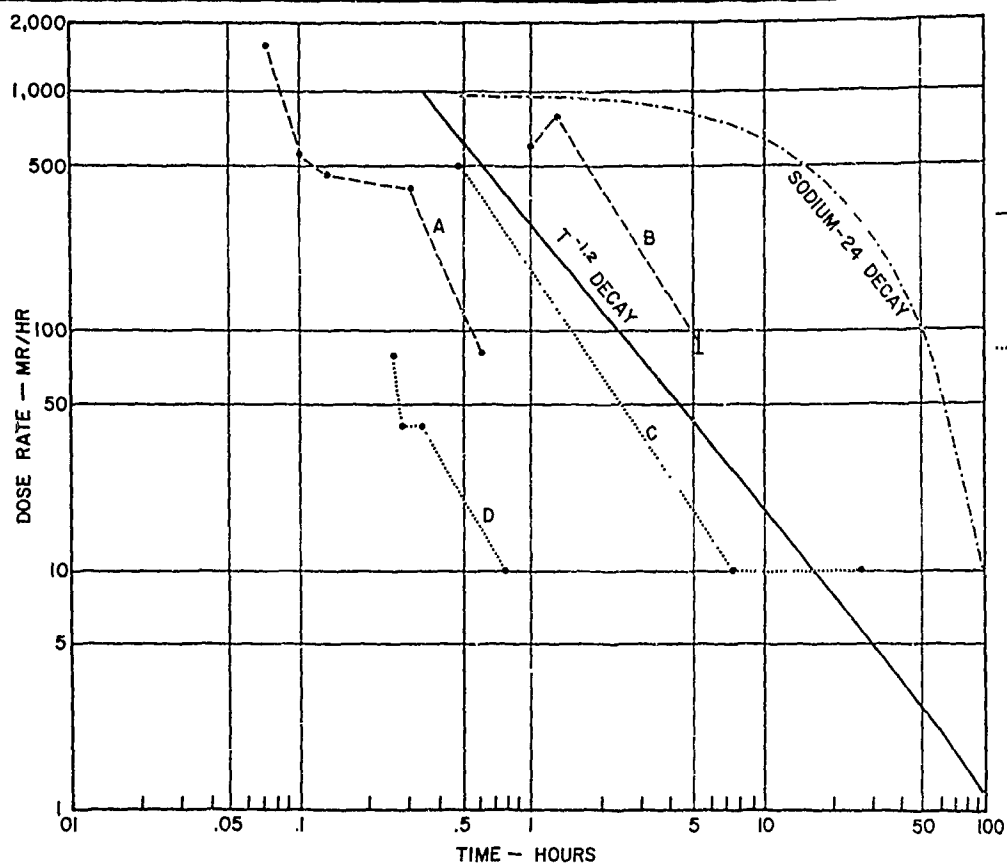


FIGURE - 3 DECAY CURVES FOR HARDTACK PHASE 2 TOWER AND GRAVEL G

--- RIO ARRIBA — 72 1/2 FT. TOWER

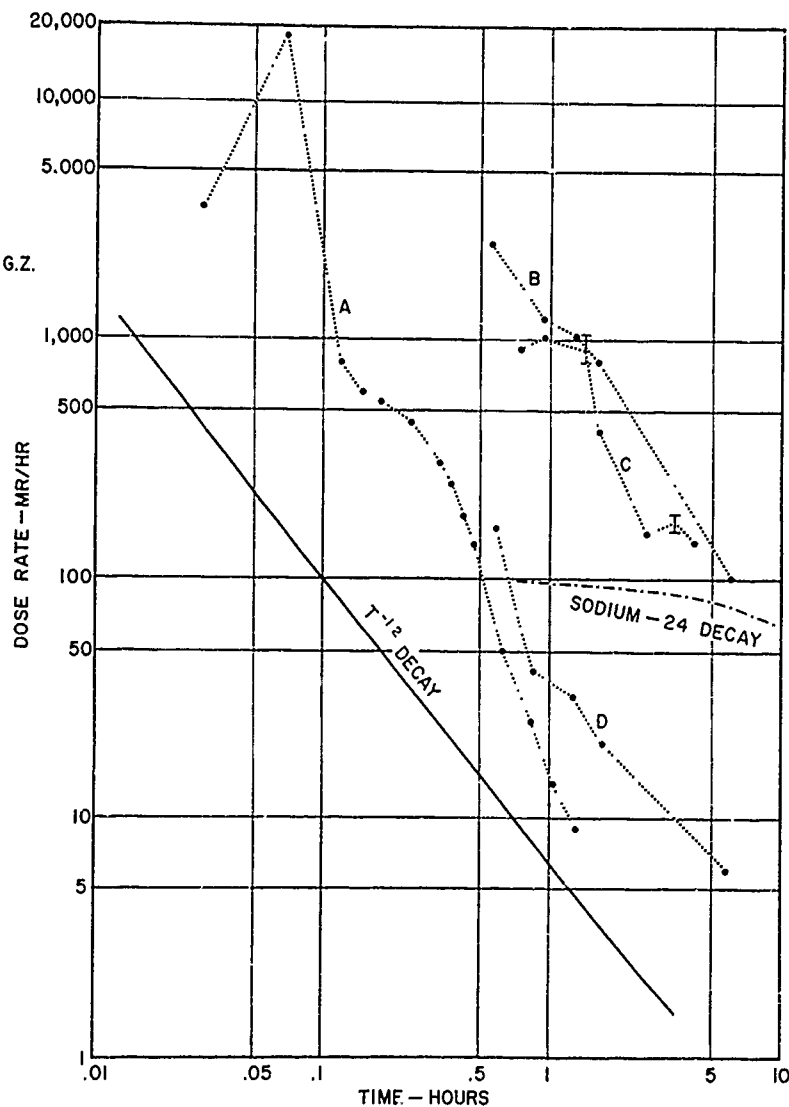
A Station 3-300 ~ 3000 ft. from G.Z.

B East winch site ~ 3.5 miles from G.Z.

..... HUMBOLDT — 25 FT. TOWER

C Station 3-330 ~ 1200 ft. from G.Z.

D Control point building 2 ~ 8 miles from G.Z.



..... VESTA — GRAVEL GERTIE

A East winch site ~ 0.5 miles from G.Z.

B West winch site ~ 1.1 miles from G.Z.

C North winch site ~ 1.5 miles from G.Z.

..... QUAY — 100 FT. TOWER

A Station 7-800 ~ 6000 ft from G.Z.

B Intersection of area 3 Main Access Road and Mercury Highway ~ 19,000 ft from G.Z.

C BJY ~ 14,000 ft. from G.Z.

D Intersection of Road "G" and Mercury Highway ~ 30,000 ft from G.Z.

┌ Indicates the range of dose rates given

USE 2 TOWER AND GRAVEL GERTIE SHOTS FOR THE ON-SITE AREA.

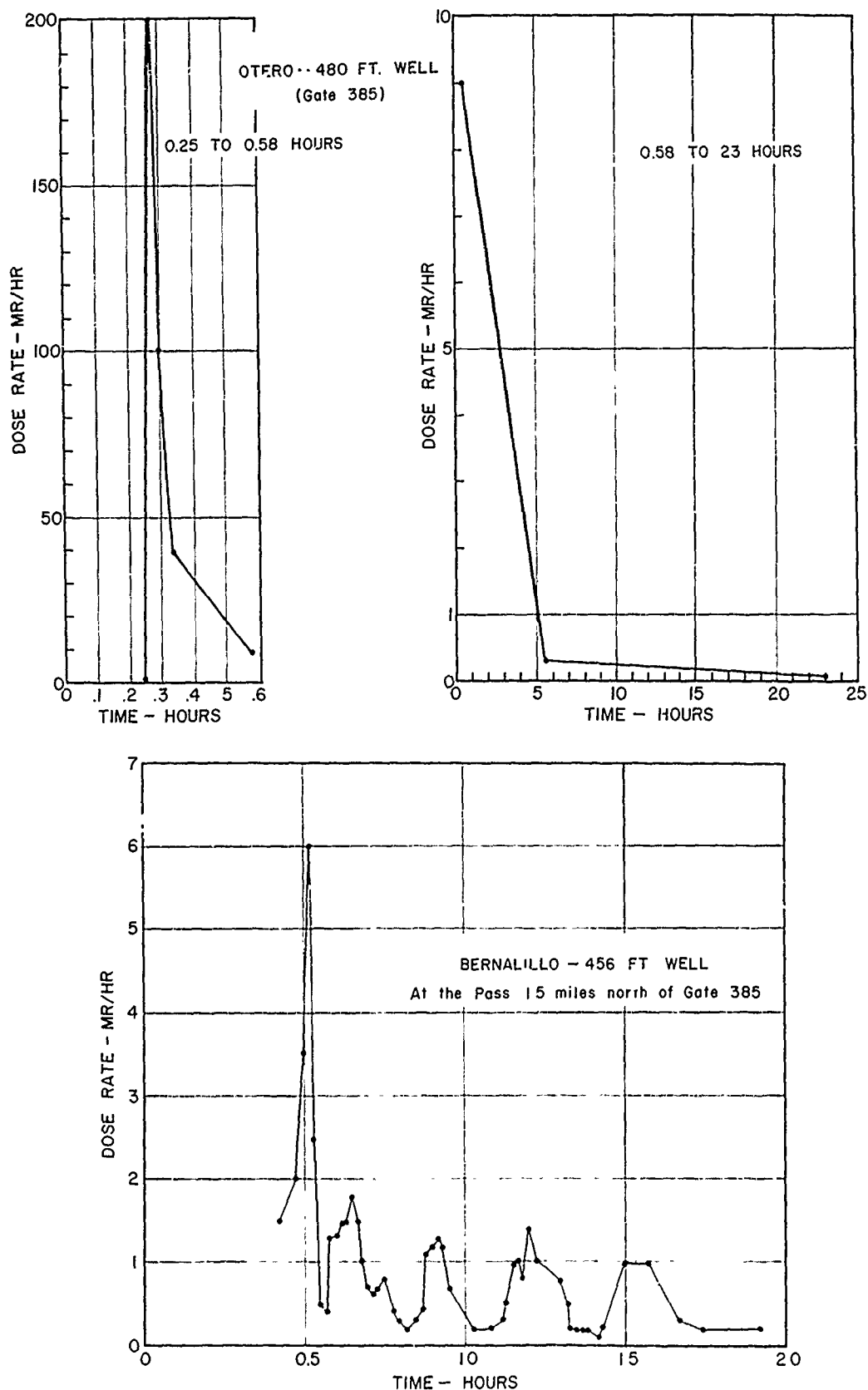
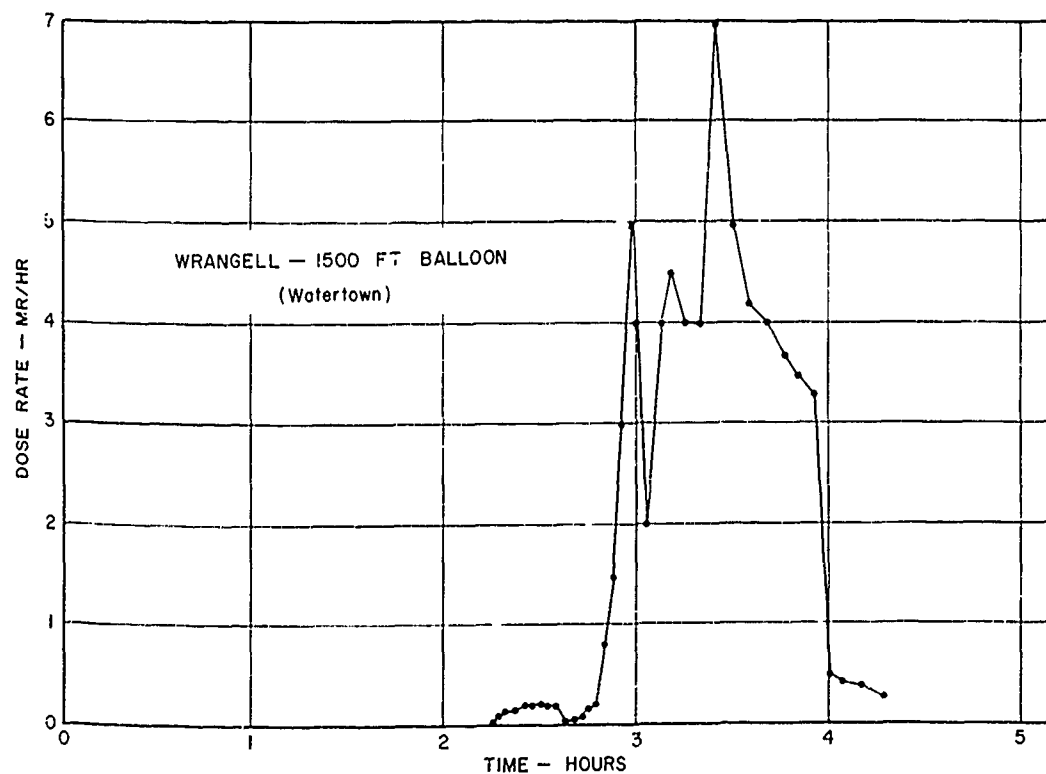
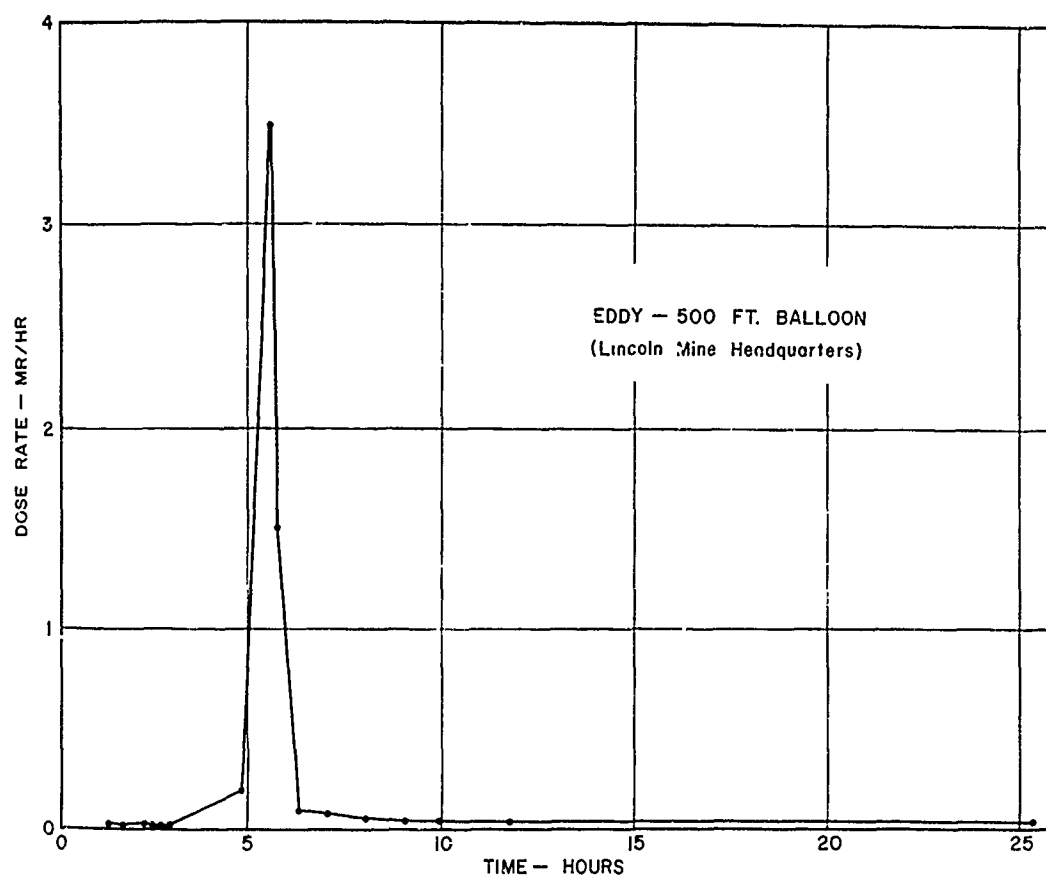


FIGURE 4 - EARLY DOSE-RATE MEASUREMENTS, SHOWING EFFECTS OF PASSING



21

EFFECTS OF PASSING RADIOACTIVE CLOUDS (WELL AND BALLOON BURSTS).

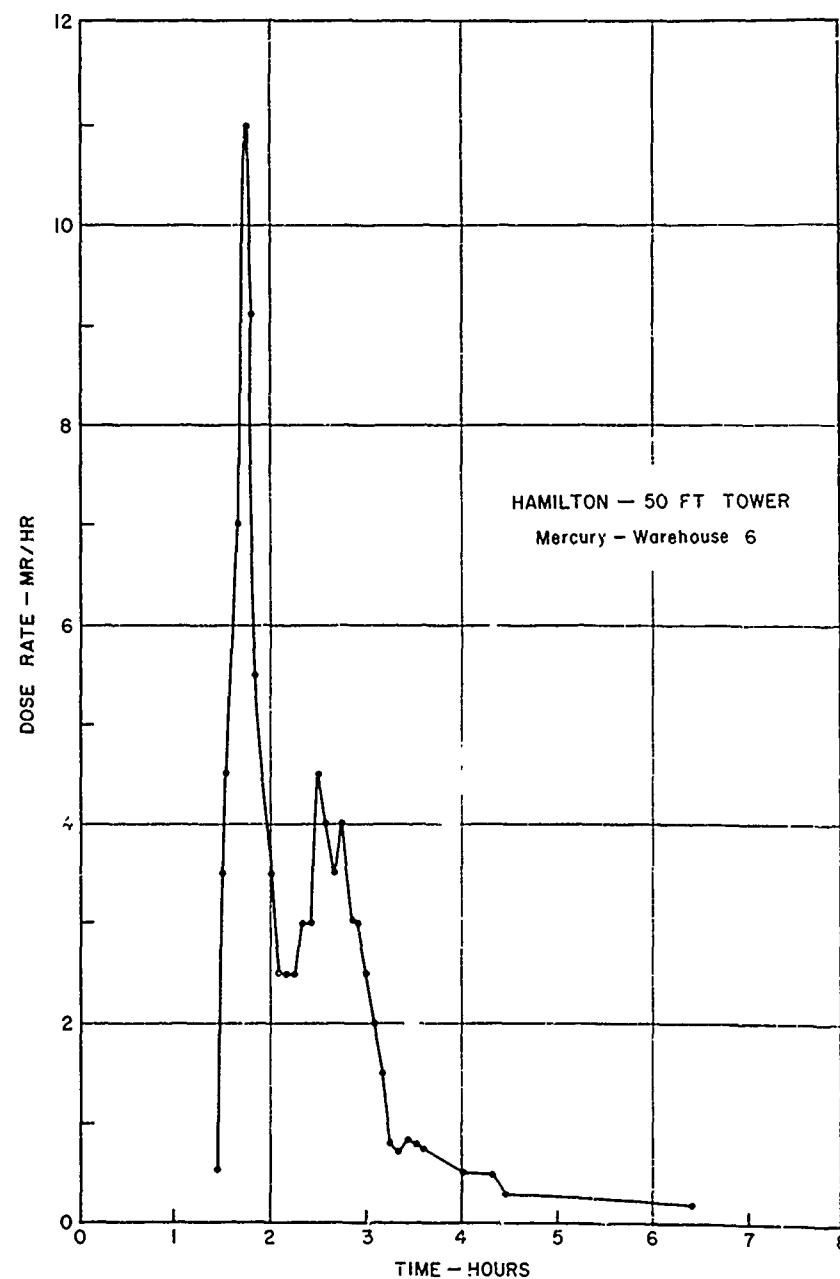
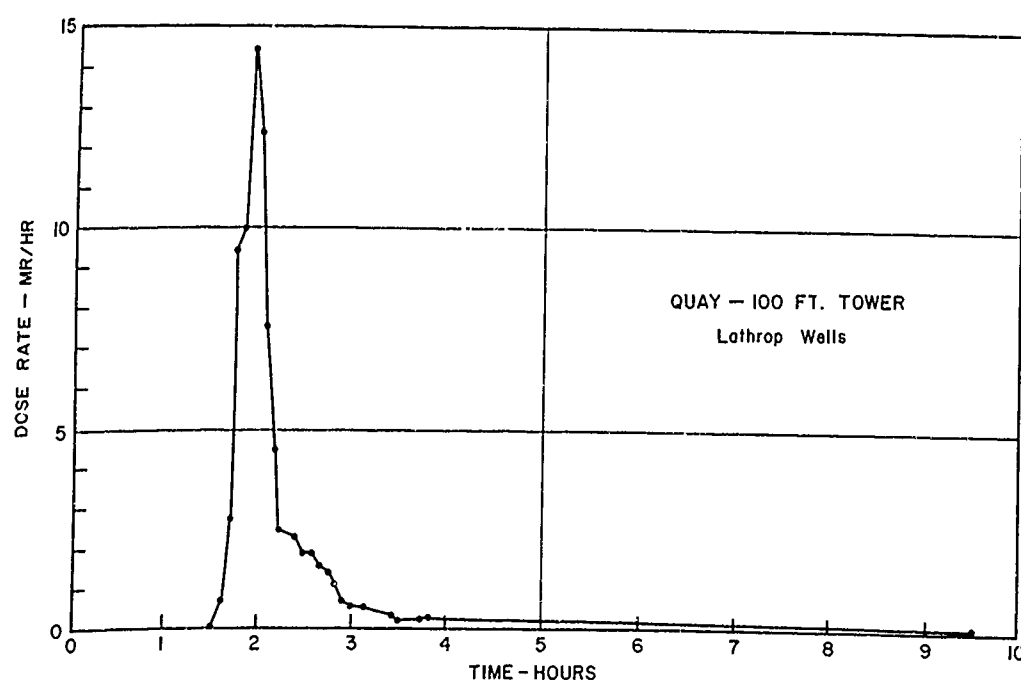
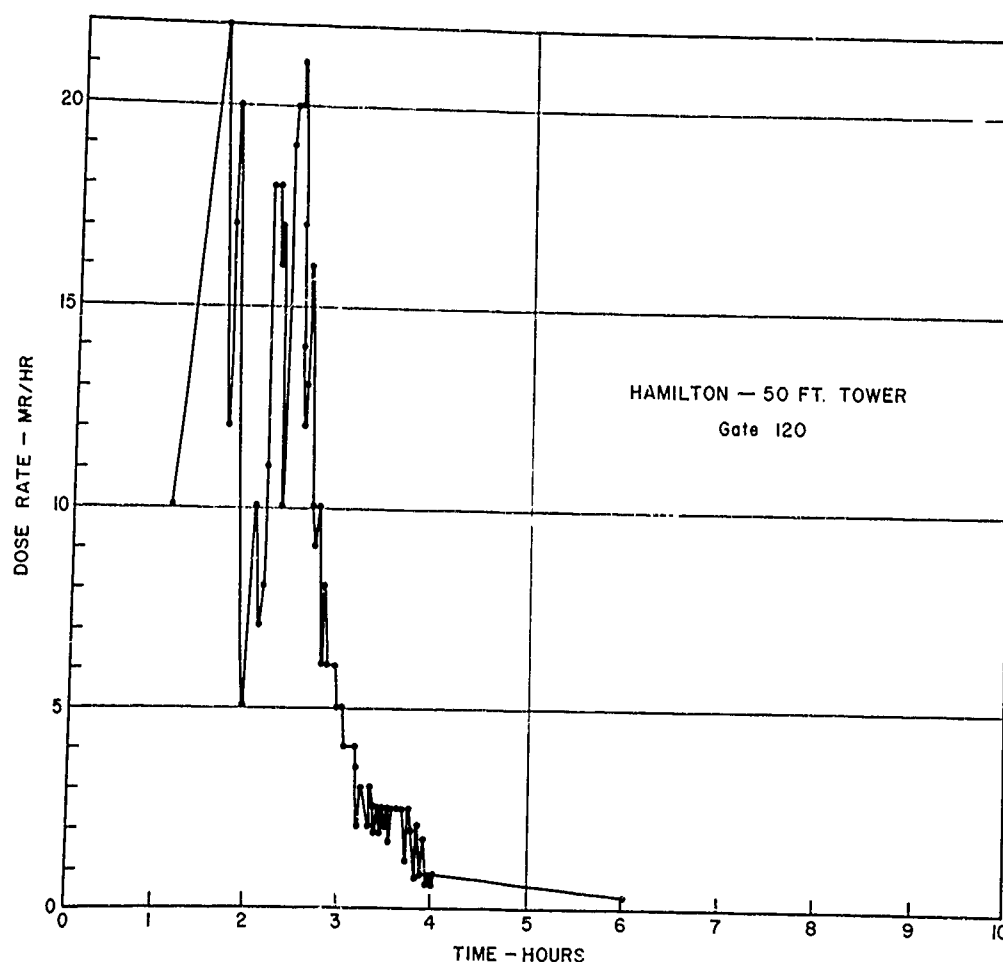


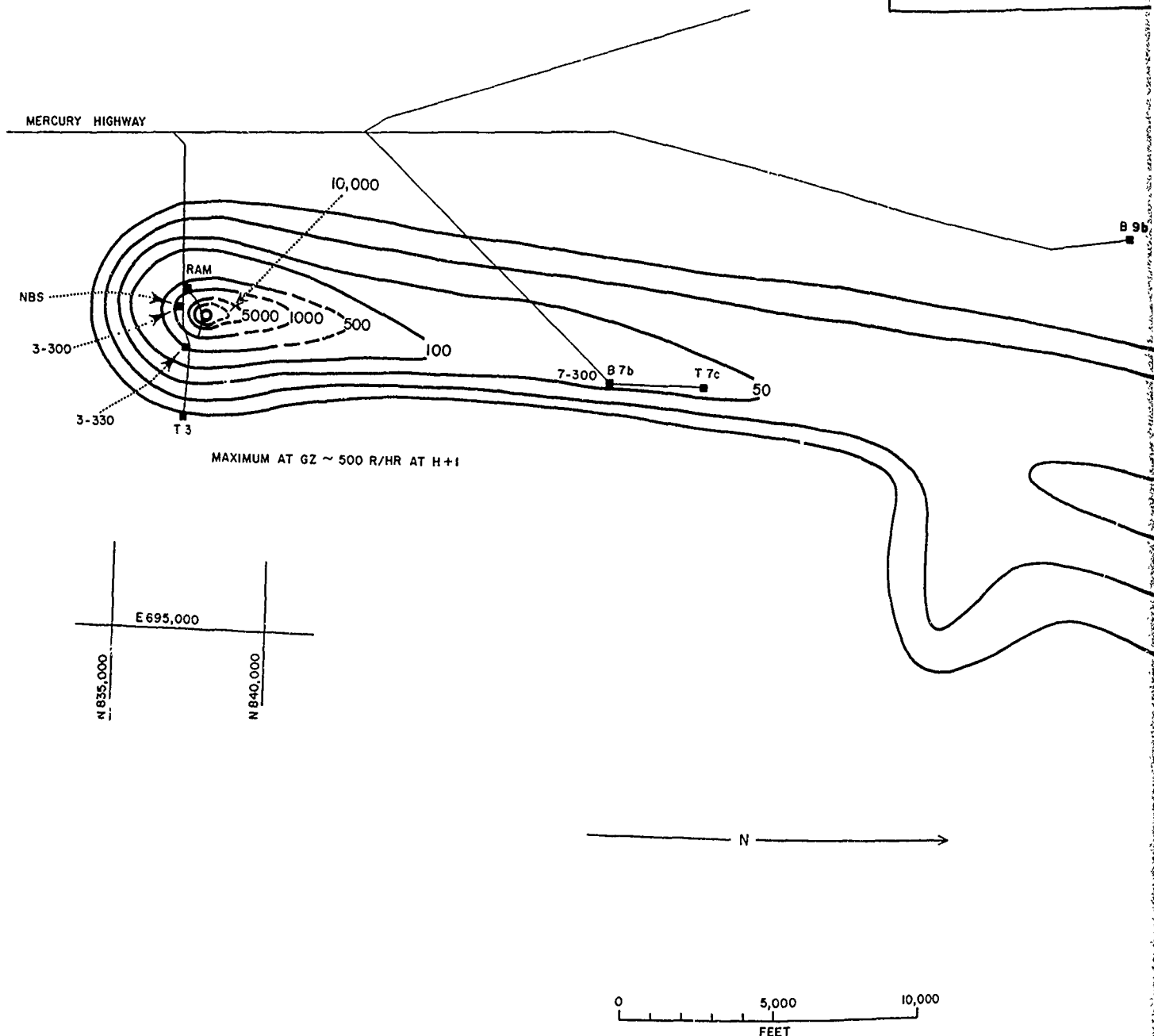
FIGURE 5 - EARLY DOSE-RATE MEASUREMENTS, SHOWING EFFECT



5. SHOWING EFFECTS OF PASSING RADIOACTIVE CLOUDS (TOWER BURSTS).

REMARKS

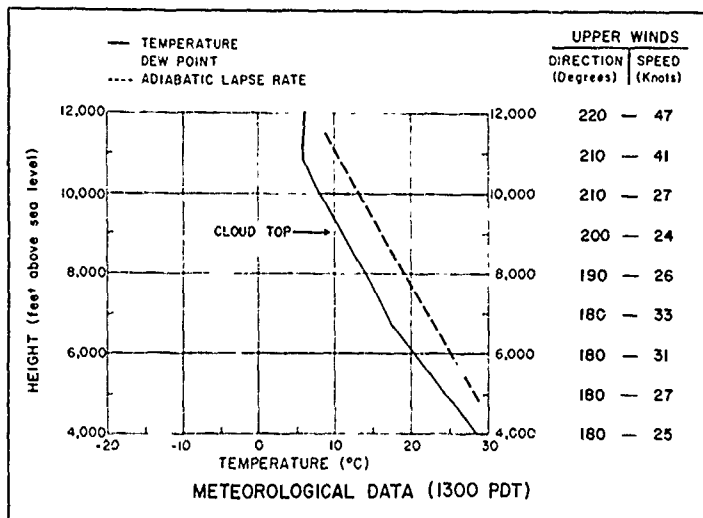
The pattern was interpolated east of Gate 300
proximation for this area in the absence of
of the on-site pattern was well documented, and



MAXIMUM AT GZ ~ 500 R/HR AT H+1

REMARKS

The pattern was interpolated east of Gate 385 and can only be an approximation for this area in the absence of measurements. The rest of the on-site pattern was well documented, and should be fairly reliable.



B 9b

GATE 385

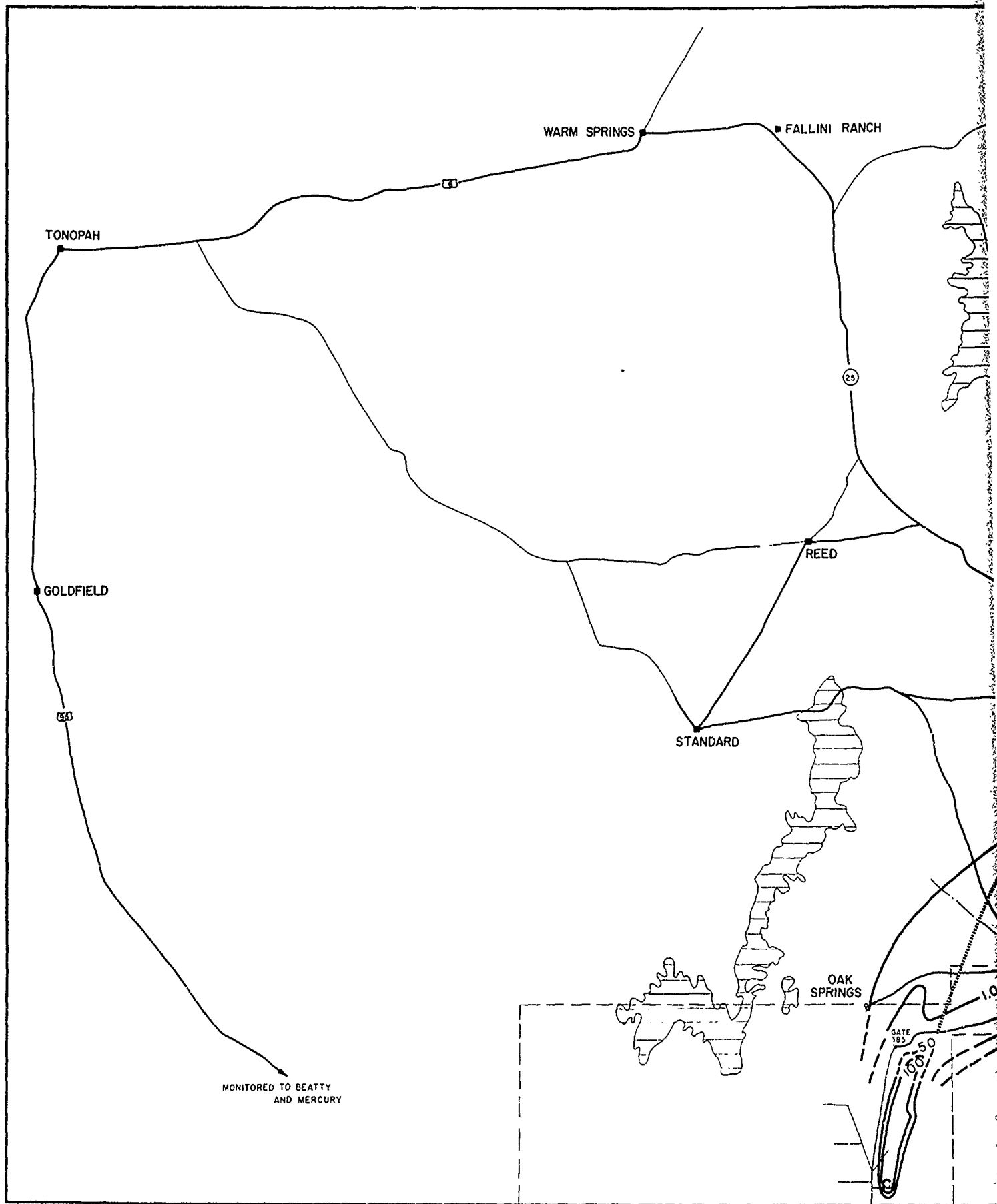
OTERO (480 FT WELL) MAP A
H-HR = 1300 PDT 12 SEPT. 1958
CLOUD TOP - 9000 FT. MSL

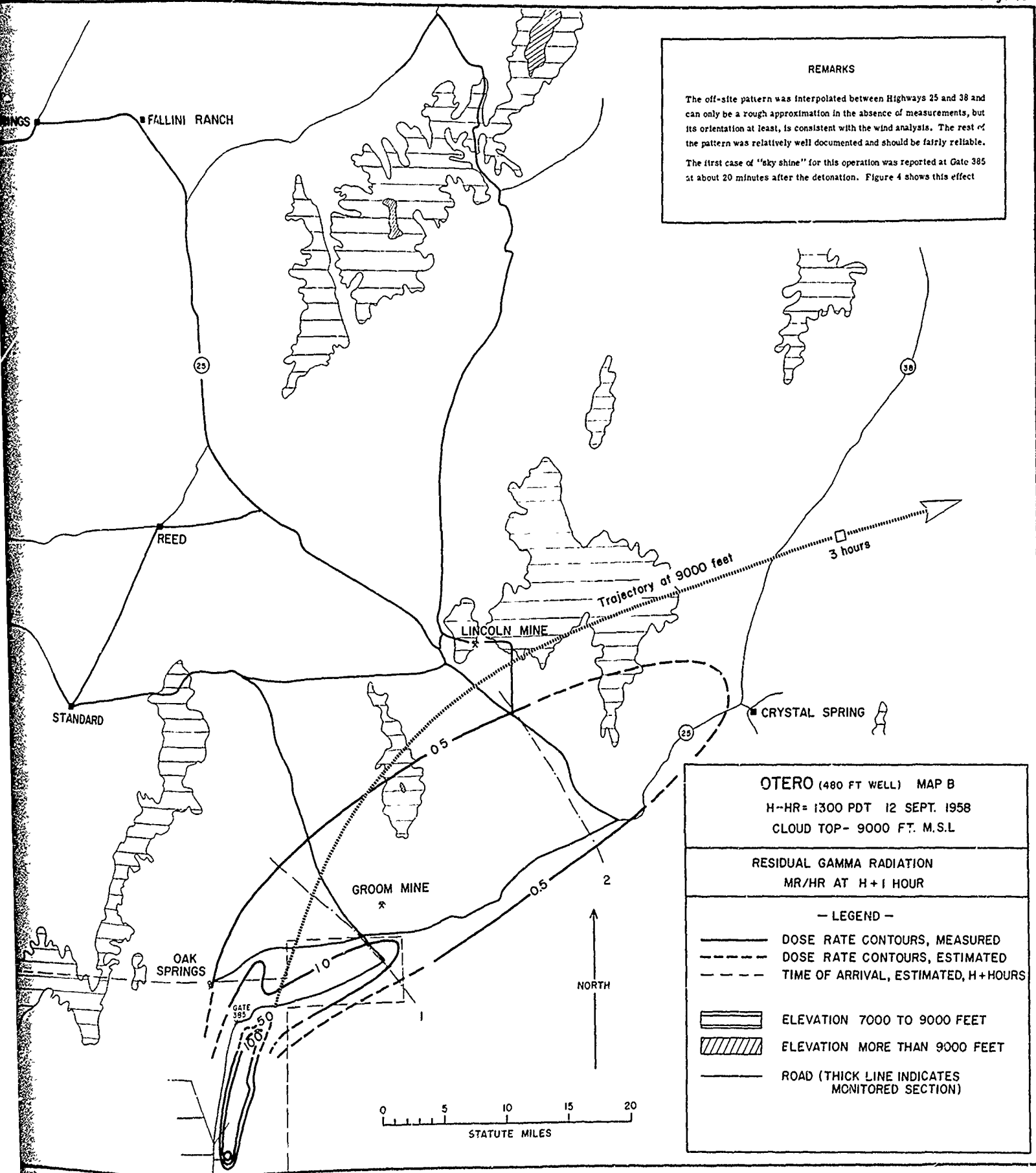
RESIDUAL GAMMA RADIATION
MR/HR AT H + 1 HOUR

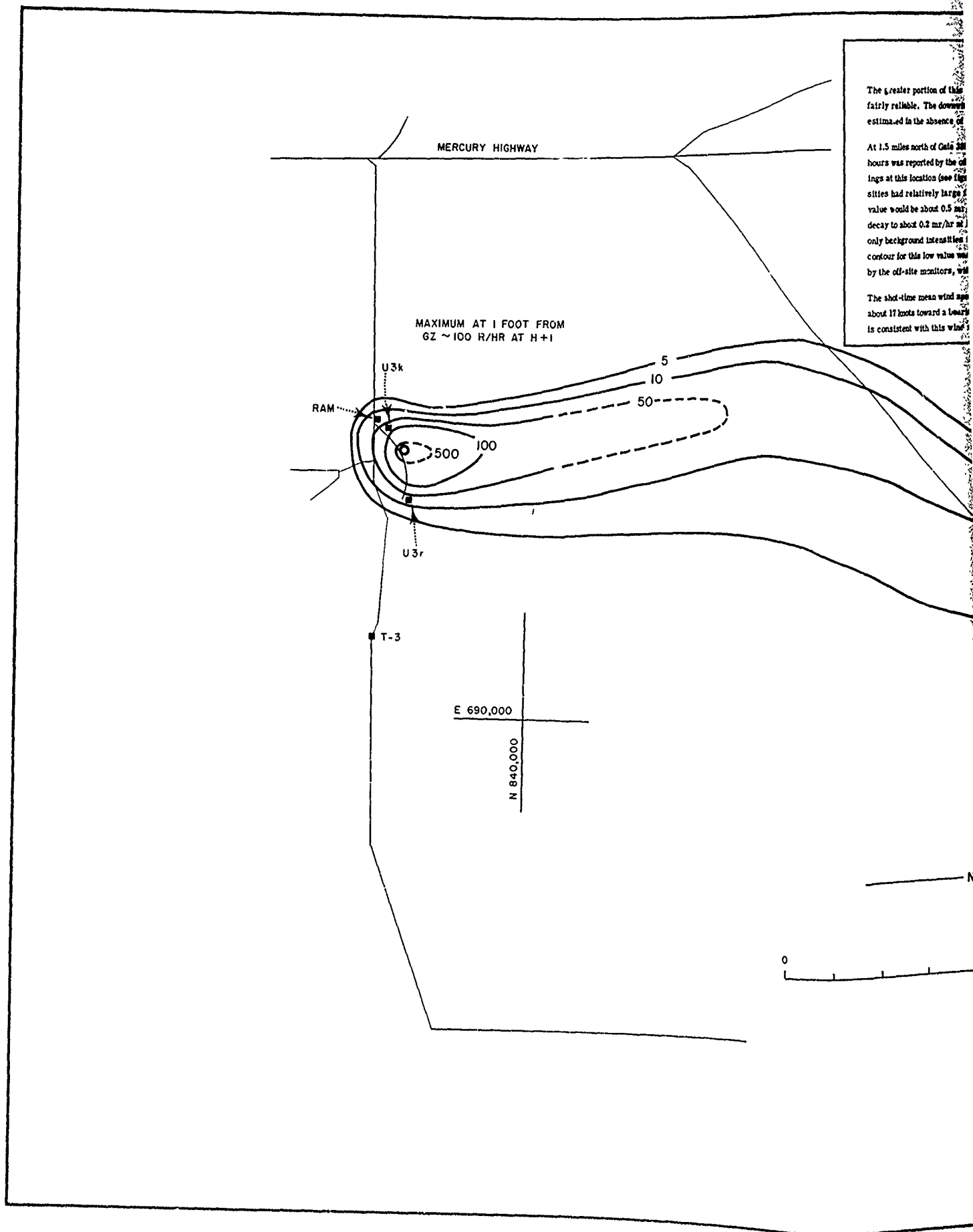
— LEGEND —

———— DOSE RATE CONTOURS, MEASURED
----- DOSE RATE CONTOURS, ESTIMATED

10,000





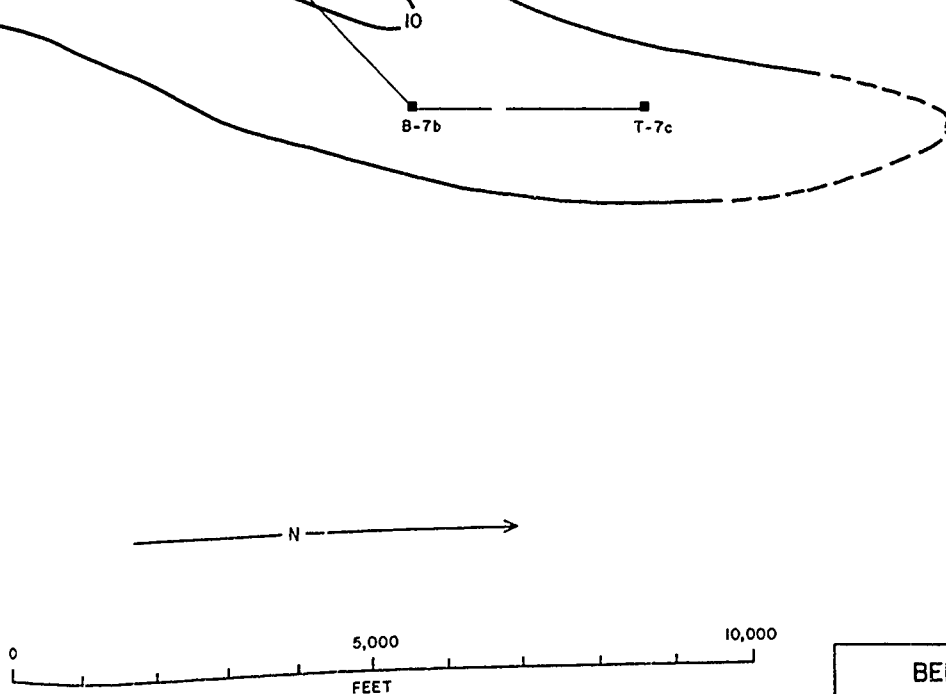
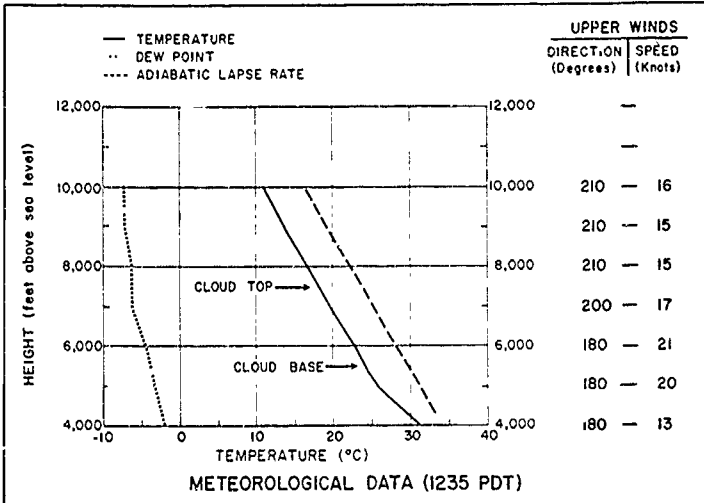


REMARKS

The greater portion of this pattern was well documented and should be fairly reliable. The downwind extent of the 50 and 5 mr/hr isolines was estimated in the absence of measurements.

At 1.5 miles north of Gate 385 a maximum dose rate of 6 mr/hr at H+0.52 hours was reported by the off-site monitors. From the continuous readings at this location (see figure 4) it can be seen that the reported intensities had relatively large fluctuation with time. An appropriate mean value would be about 0.5 mr/hr at H+1 hour and since other monitors indicated only background intensities in the areas to the north of this position, no contour for this low value was drawn. No significant fallout was reported by the off-site monitors, with the exception mentioned above.

The shot-time mean wind speed from the surface to 7,500 feet m.s.l. was about 17 knots toward a bearing of about 360 degrees. The fallout pattern is consistent with this wind analysis.



BERNALILLO (456 FT WELL) MAP A

H-HR = 1230 PDT 17 SEPT 1958

CLOUD TOP - 7500 FT M S L

RESIDUAL GAMMA RADIATION
MR/HR AT H + 1 HOUR

- LEGEND -

———— DOSE RATE CONTOURS, MEASURED
 - - - - DOSE RATE CONTOURS, ESTIMATED

REMARKS

The on-site monitoring for this event was adequate. The surveys, the on-site group made a special survey north and the surrounding area. It is difficult to say with any was being monitored during this special survey was residual gamma activity, or a combination of both since taken at each position. Therefore, the decay rate for this area. To add to this confusion, residual activity detonations was known to exist in this general area a percent of what was observed. Since the observed rate average about 0.4 mR/hr at 8 + 10 hours, this would be to the total close-in fallout fraction. No pattern was on either the on-site or off site map.

SOUTH WINCH SITE

B-7h

T-7c

1000

100

MAXIMUM AT GZ ~ 8 R/HR AT H+1

10

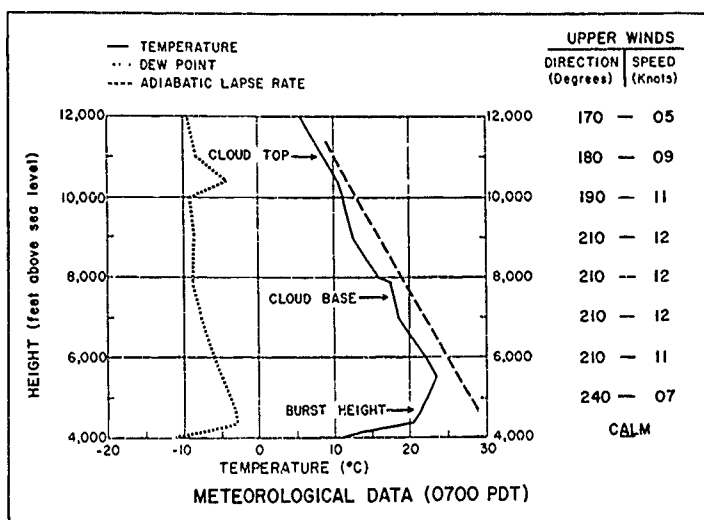
E 695,000

N 850,000

0 5,000 FEET

REMARKS

The on-site monitoring for this event was adequate. Besides their regular surveys, the on-site group made a special survey north of T-7c to Gate 385 and the surrounding areas. It is difficult to say with any confidence if what was being monitored during this special survey was induced activity, residual gamma activity, or a combination of both since only one reading was taken at each position. Therefore, the decay rate could not be estimated for this area. To add to this confusion, residual activity from Plumbbob detonations was known to exist in this general area and to be at least 30 percent of what was observed. Since the observed readings were on the average about 0.4 mr/hr at H + 10 hours, this would not add significantly to the total close-in fallout fraction. No pattern was drawn for this area on either the on-site or off-site map.



B-9b

N →

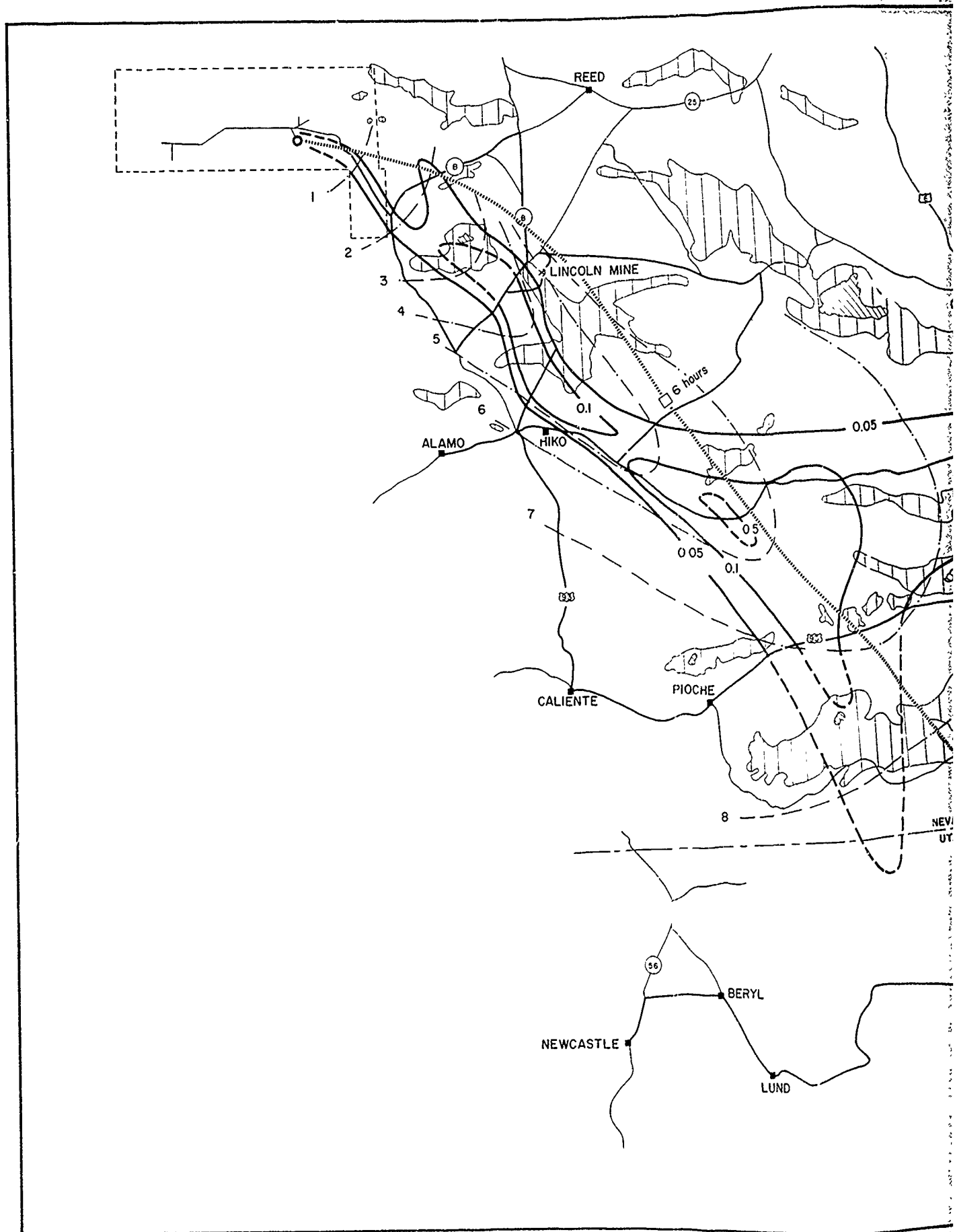
EDDY (500 FT BALLOON) MAP A
 H-HR=0700 PDT 19 SEPT 1958
 CLOUD TOP=11,000 FT MSL

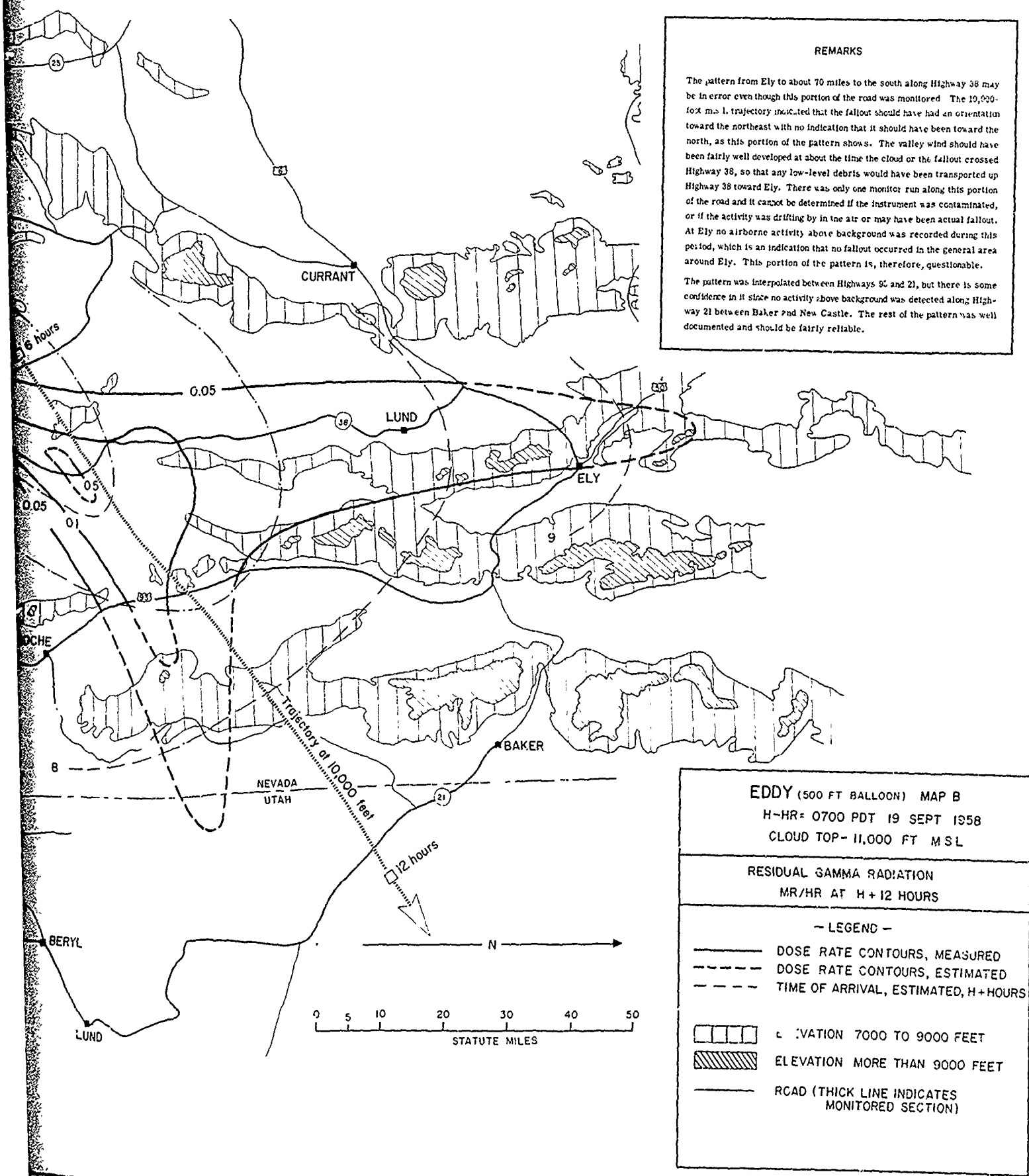
RESIDUAL GAMMA RADIATION
 MR/HR AT H+1 HOUR

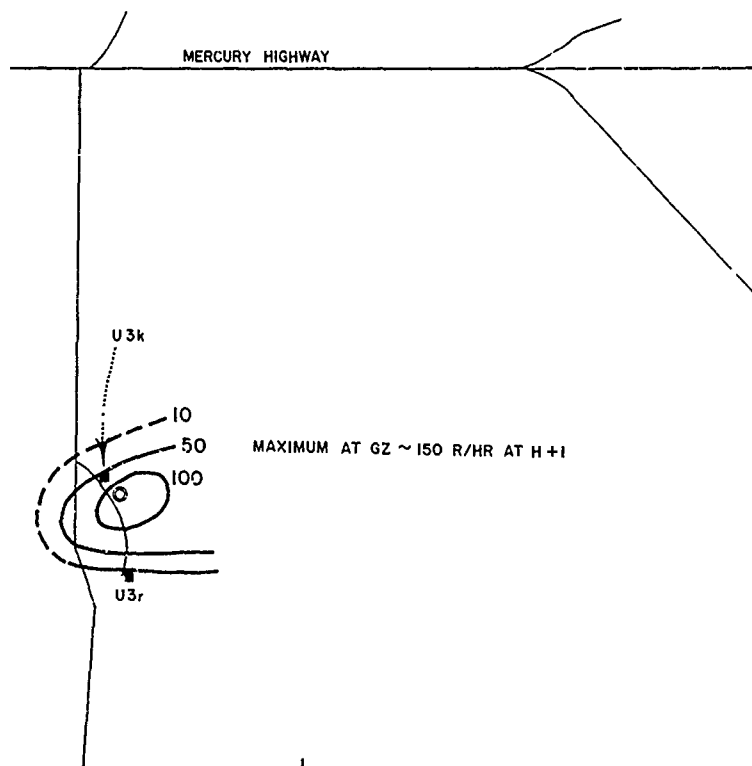
— LEGEND —

— DOSE RATE CONTOURS, MEASURED
 --- DOSE RATE CONTOURS, ESTIMATED

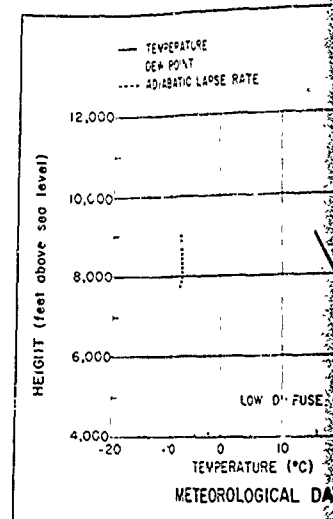
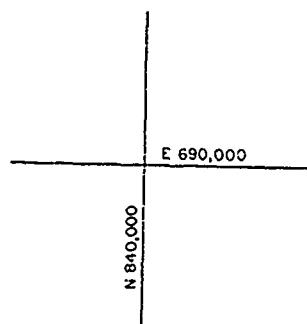
0 5,000 10,000
 FEET







MAXIMUM AT GZ ~ 150 R/HR AT H+1

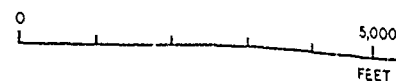


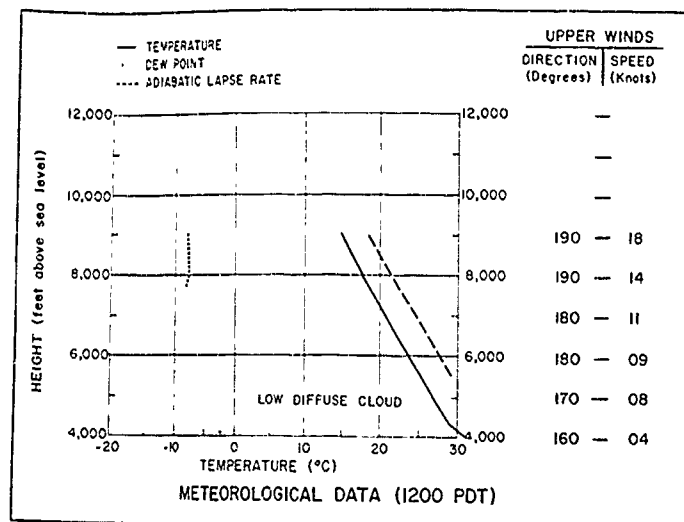
ESTIMATED AXIS OF FALLOUT 355°

6 MR/HR AT H+1 ▲ JAPANESE HOUSES

7-300

T-7c 4 MR/HR





ESTIMATED AXIS OF FALLOUT 355°

JAPANESE HOUSES

7-300

T-7c

4 MR/HR AT H+1

N

5,000

FEET

10,000

REMARKS

Based on the shot time wind run the Luna fallout should have had a hot line bearing of about 355 degrees. Since there were few monitor runs across this bearing it is difficult to draw a pattern with any confidence.

There appeared to have been some fallout at the Japanese Houses. Site T-7c and the Area 9 ground zero. At the Japanese Houses a reading of 6 mr/hr, converted to H+1, was reported. There did not appear to be any residual contamination from previous events in this area.

At Site T-7c there was a background contamination of about 2 mr/hr from the Eddy burst at the time of the Luna detonation. Subtracting this from the Luna monitor reading would leave a dose rate of about 4 mr/hr at H+1.

The Area 9 ground zero, which is about 6 miles from the Luna position on a bearing of about 357 degrees, was reported to have only background radiation at 16 minutes after shot time. At 20 and 29 minutes the readings there were 5 and 10 mr/hr, respectively. From the shot time wind speed (about 10 knots from the surface to 9,000 feet, m.s.l.) the cloud passage and the fallout should have occurred at about 30 minutes after shot time. It is thus difficult to estimate the H+1 value since the activity was apparently still arriving at the time of the last observation.

For Site 7-300 the background contamination from the Eddy event was of the order of 200 to 300 mr/hr 5 hours before the Luna detonation or 48 hours after the Eddy burst. Taking a value of 250 mr/hr at 48 hours and decaying it (sodium-24 decay) to 54 and 72 hours (which are equivalent to the H+1 and the H+19 Luna surveys) we would arrive at values of 200 and 100 mr/hr respectively. Since the readings on the Luna surveys at these times were of this order or less, we can assume that it was primarily residual Eddy contamination that was being monitored.

Again, since there were so few significant readings downwind from the Luna ground zero, no attempt was made to draw a complete pattern.

There were no readings above background reported off-site.

LUNA (484 FT WELL) MAP A

H-HR = 1200 PDT 21 SEPT 1958

CLOUD TOP - LOW DIFFUSE CLOUD

RESIDUAL GAMMA RADIATION

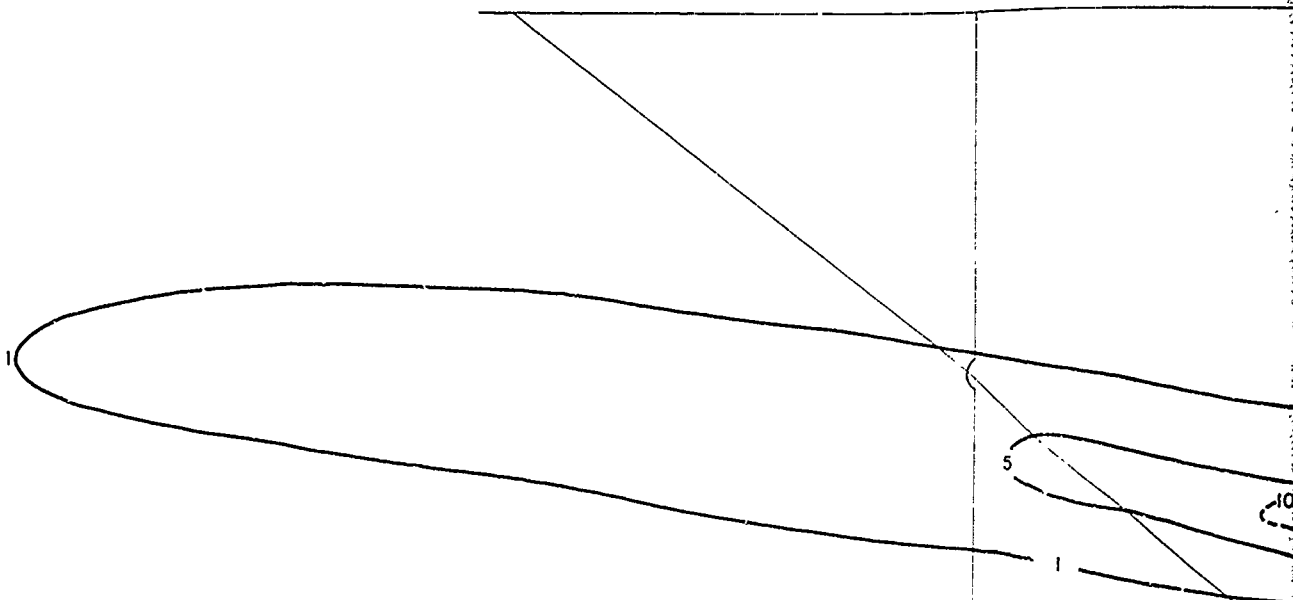
MR/HR AT H+1 HOUR

— LEGEND —

———— DOSE RATE CONTOURS, MEASURED

----- DOSE RATE CONTOURS, ESTIMATED

MERCURY HIGHWAY

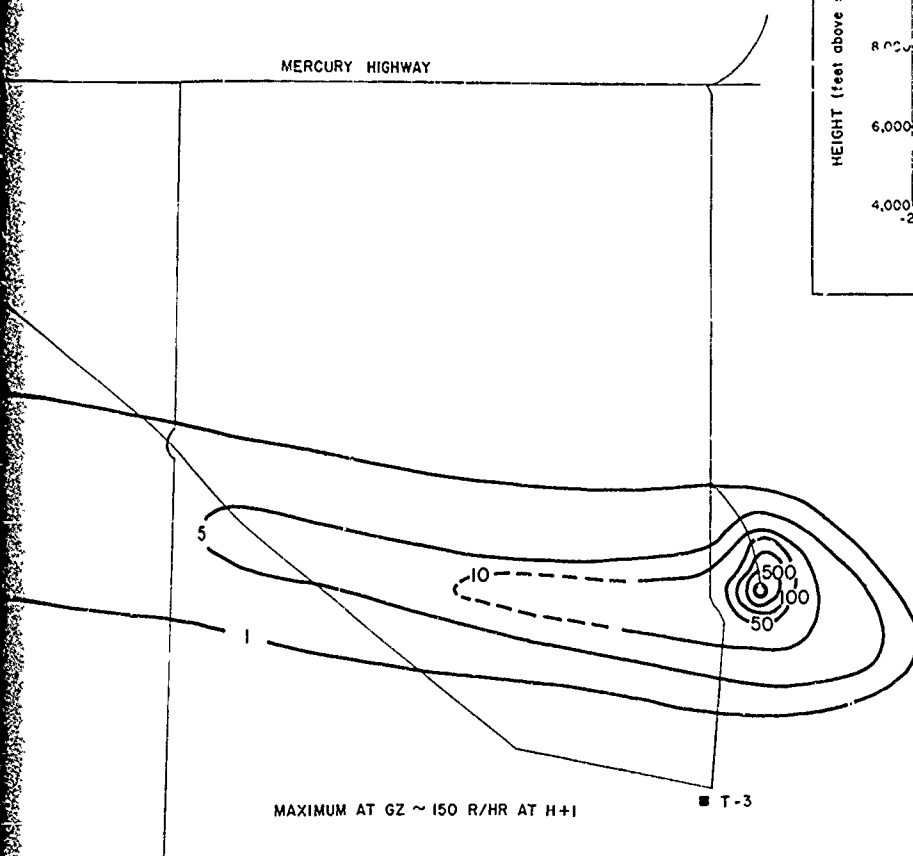
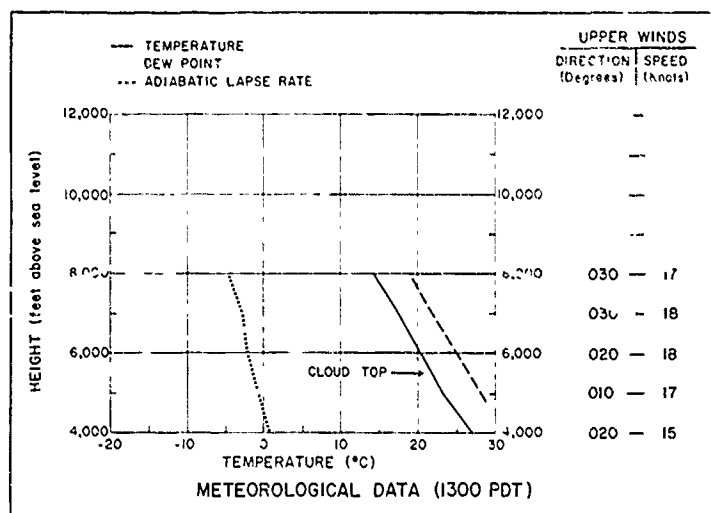


MAXIMUM AT GZ ~ 150 R/

E 690,000

N 825,000

0



REMARKS

The Valencia cloud moved at a speed of about 16 knots along a bearing of about 195 degrees from ground zero. At about 1 1/2 hour after shot time, although the cloud was not visible, readings at Control Point Building 2 (approximately 8 miles from ground zero on a bearing of about 185°) rose rapidly to 9 mr/hr and then dropped rapidly to 0.35 ml/hr. The mean wind speed and direction show that the cloud should have been in this general area at about the time of this maximum reading, indicating that what was being recorded was sky shine.

Special surveys across Yucca Lake to Area II, west of the Mercury Highway, and along the Cane Spring road to Jackass Flats showed that there was no activity above background or above the levels of residual contamination from previous events. It, therefore, seems doubtful that there could have been additional areas of fallout on-site. In general, the documentation was such as to yield a high degree of confidence in the analysis.

No interstices significantly above background were found by the off-site monitors.

VALENCIA (484 FT WELL) MAP A

H-HF = 1300 PDT 26 SEP 1958

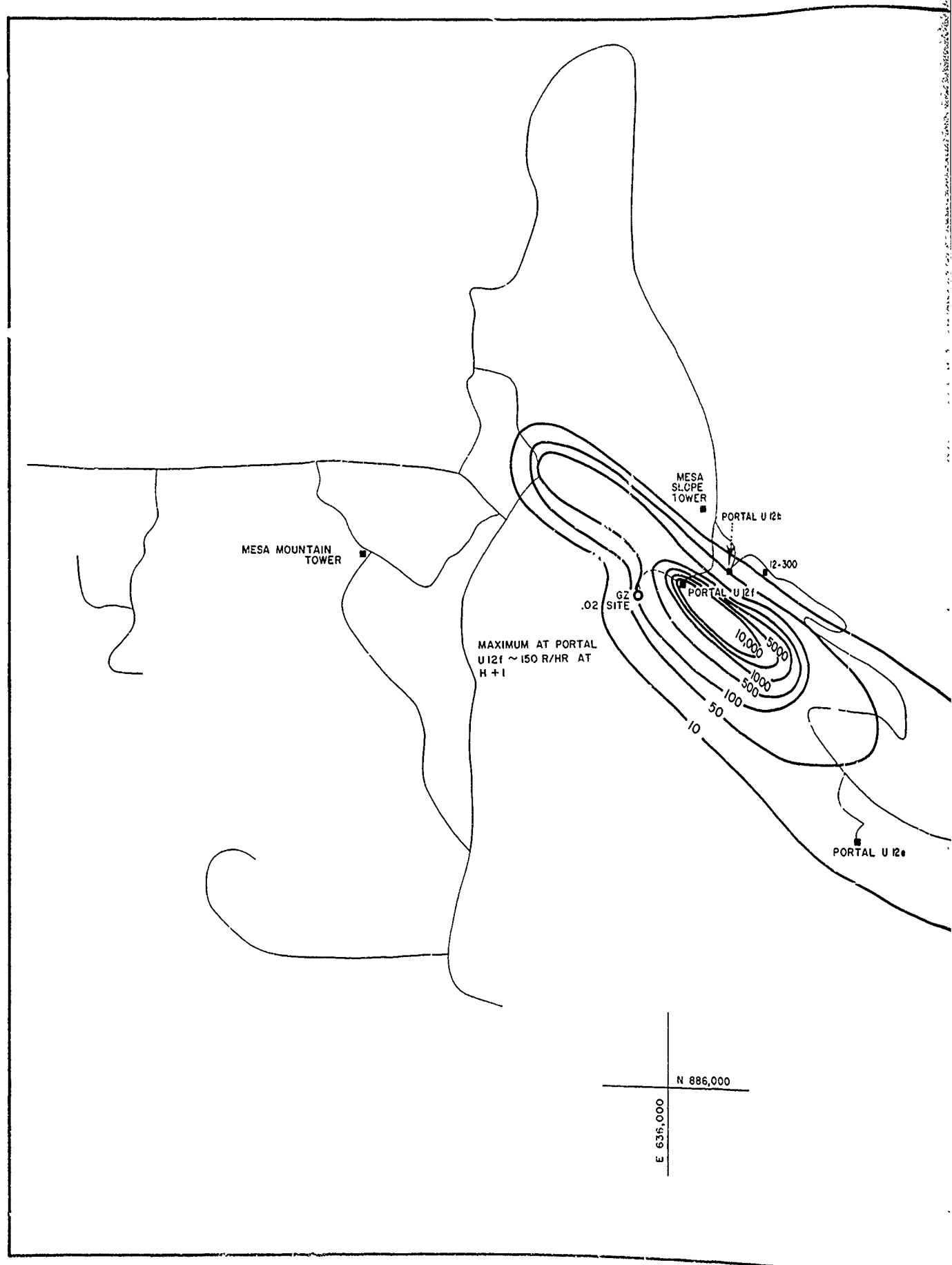
CLOUD TOP - 5500 FT MSL

RESIDUAL GAMMA RADIATION

MR/HR AT H+1 HOUR

- LEGEND -

- DOSE RATE CONTOURS, MEASURED
 --- DOSE RATE CONTOURS, ESTIMATED



REMARKS

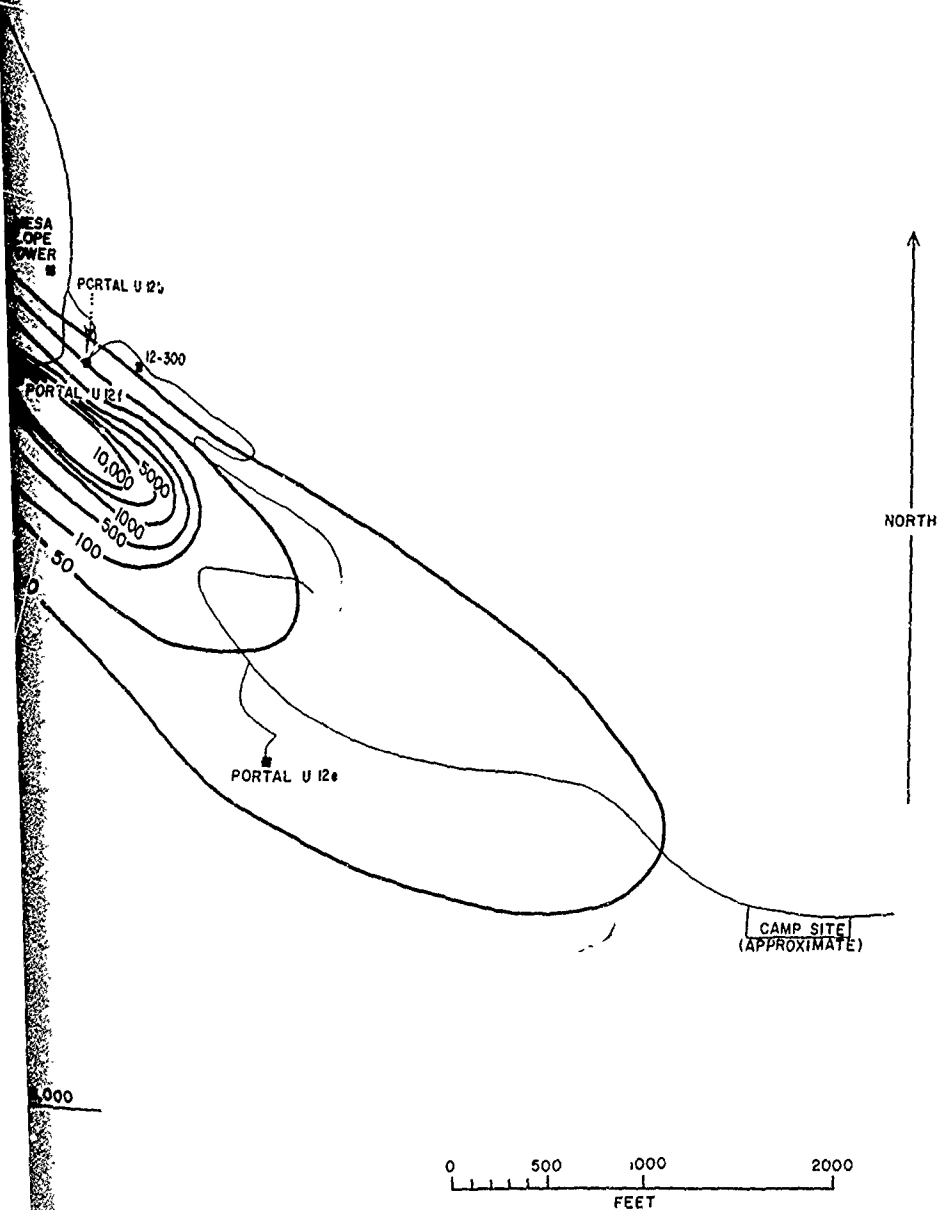
Mars vented through the tunnel mouth (situated on the mesa slope at an elevation of 6,725 feet m.s.l.), and a cloud rose to only a few hundred feet above the surface. Before shot time the winds along the mesa slope (see table below) were approximately from the northeast with the winds over the mesa top also from about northeast. Two minutes before shot time the winds at the slope station shifted and blew from approximately northwest (drainage winds), while the winds over the mesa slope were still from about northeast. Since the cloud rose to only a few hundred feet, it was under the influence of the drainage winds and travelled toward the southeast.

The only road which could be monitored in the direction of fallout was the Area 12 access road, therefore, there is considerable uncertainty as to the cross-wind extent of this pattern. The down-wind and up-wind extent of the contamination should be fairly reliable.

No activity above background was detected off-site.

10-Minute Average Winds

9-foot Mesa Slope Tower (Surface Elevation-6,725 feet m.s.l.)			100-foot Mesa Mountain Tower (Surface Elevation-7,475 feet m.s.l.)		
Time (PDT)	Direction (degrees)	Speed m.p.h.	Time (PDT)	Direction (degrees)	Speed m.p.h.
1545-1600	040	03	1545-1600	060	14
1645-1657	040	02	1645-1700	060	07
1658	Reversal				
1745-1800	320	08	1745-1800	025	21
1845-1900	330	06	1845-1900	035	21
1945-2000	320	05	1945-2000	045	20



MARS (TUNNEL) MAP A

H-HR = 1700 PDT 27 SEPT 1958

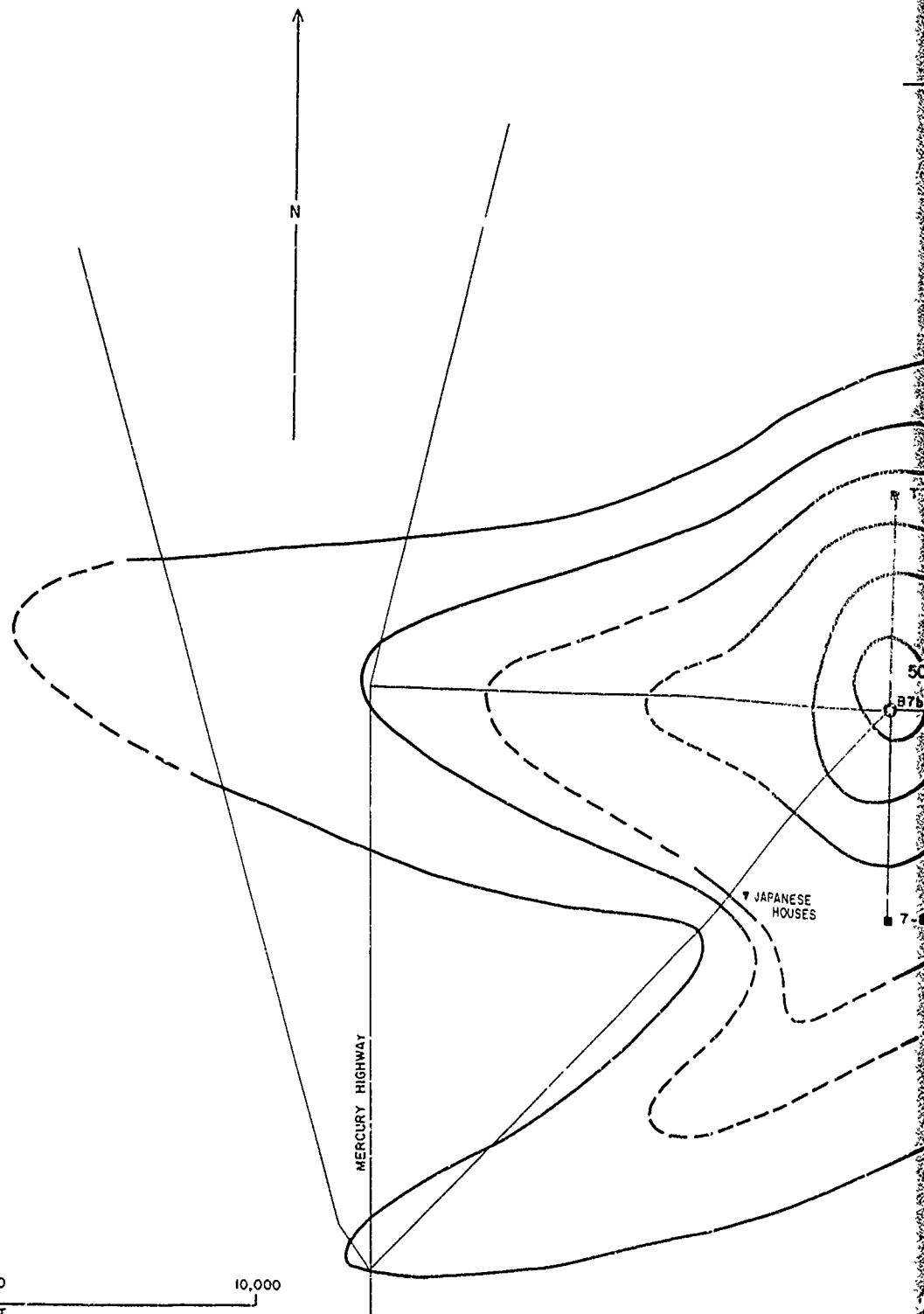
CLOUD TOP - LOW DIFFUSE CLOUD

RESIDUAL GAMMA RADIATION

MR/HR AT H + 1 HOUR

- LEGEND -

- DOSE RATE CONTOURS, MEASURED
 - - - - DOSE RATE CONTOURS, ESTIMATED

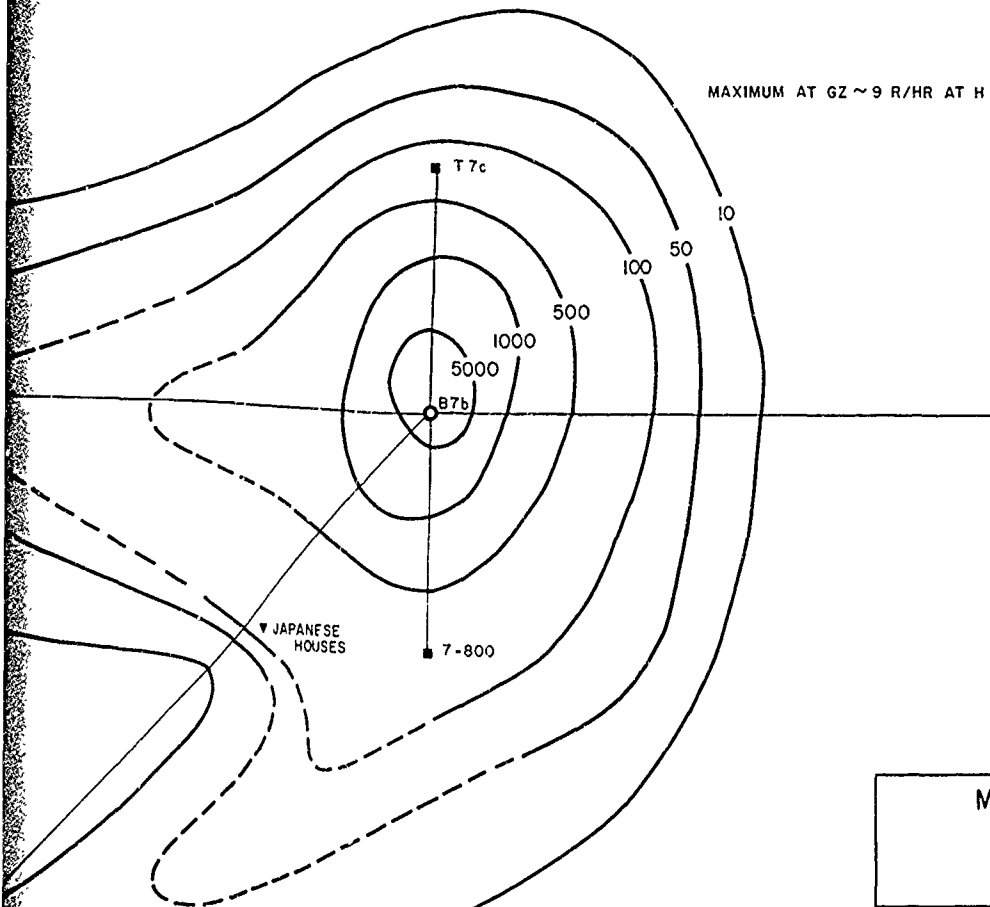


REMARKS

At shot time a dust cloud was formed (most likely by the shock wave kicking up the surface dirt) in the lower levels and was observed to move toward the west over the Mercury Highway producing relative, high fall-out activity. This dust cloud most likely contained primarily induced radioactivity formed by the neutron capture by the sodium in the soil. Since this event was fairly well documented on site, there is considerable confidence in the pattern presented.

E 690,000
N 860,000

MAXIMUM AT GZ ~ 9 R/HR AT H+1



MORA (1500 FT BALLOON) MAP A

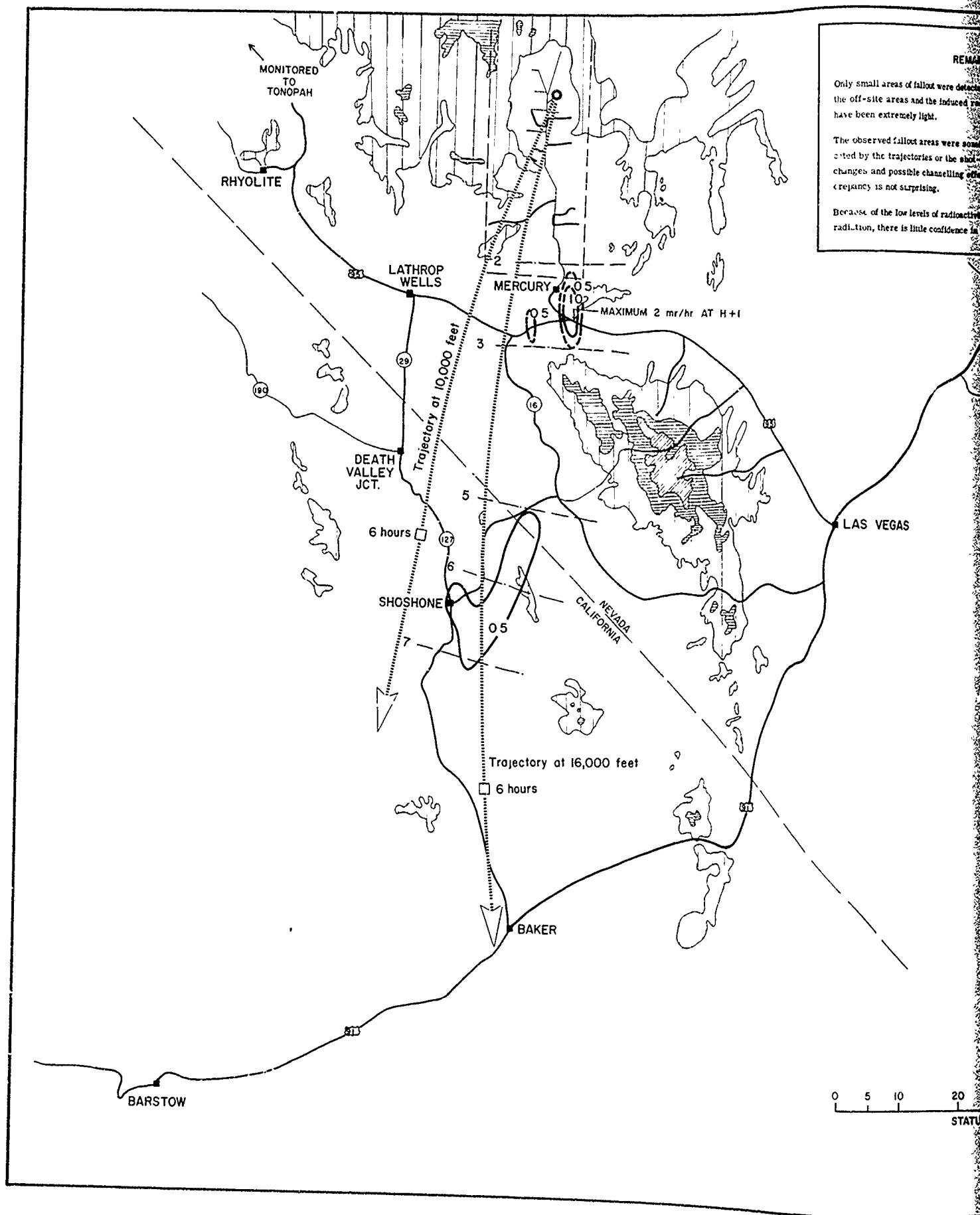
H-HR = 0605 PST 29 SEPT 1958

CLOUD TOP - 18,500 FT. M.S.L.

RESIDUAL GAMMA RADIATION
MR/HR AT H+1 HOUR

- LEGEND -

———— DOSE RATE CONTOURS, MEASURED
----- DOSE RATE CONTOURS, ESTIMATED



REMA

Only small areas of fallout were detected in the off-site areas and the induced fallout have been extremely light.

The observed fallout areas were somewhat affected by the trajectories or the wind changes and possible channelling effect. A discrepancy is not surprising.

Because of the low levels of radioactive radiation, there is little confidence in

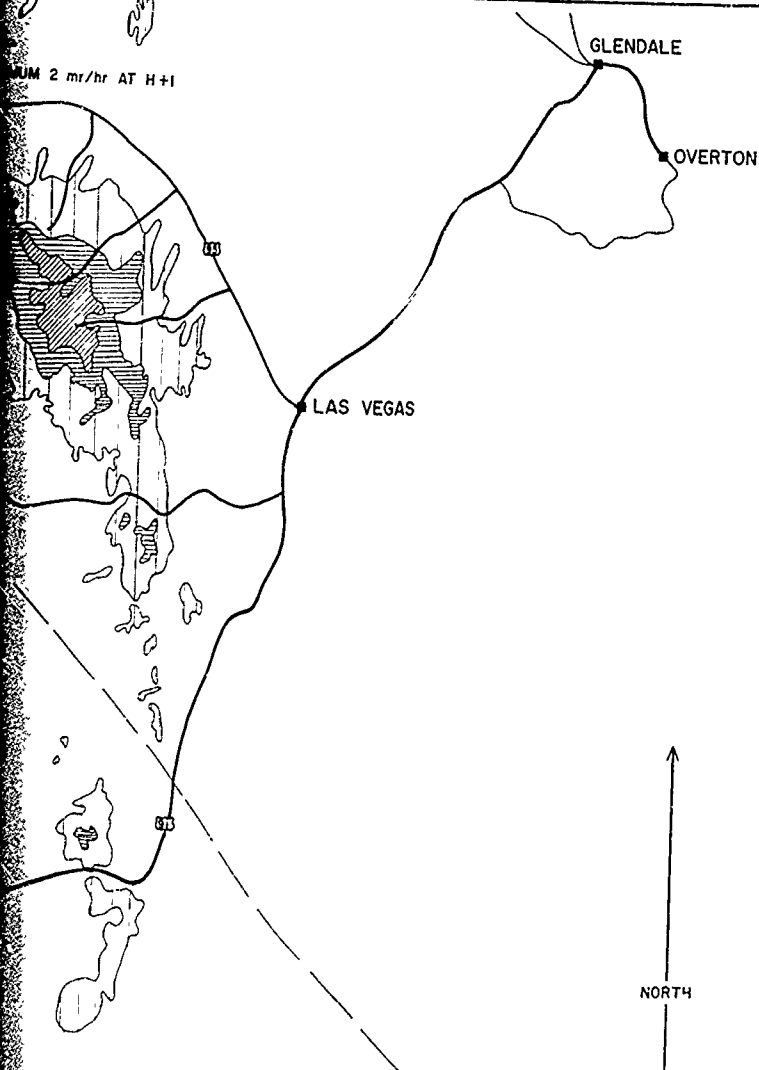
REMARKS

Only small areas of fallout were detected off site, and any fallout between the off-site areas and the induced radiation near the burst point must have been extremely light.

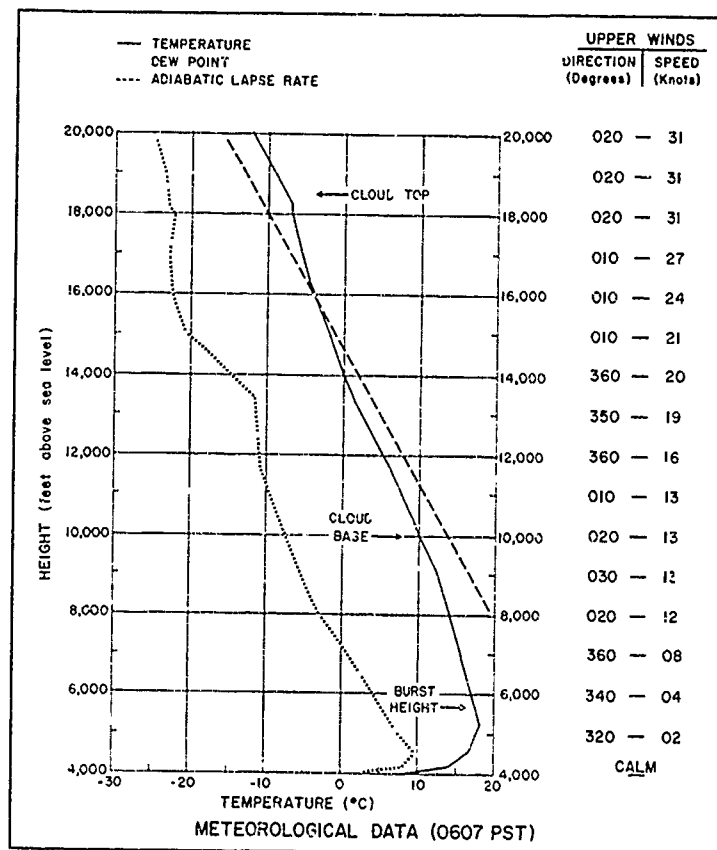
The observed fallout areas were somewhat to the east of the path indicated by the trajectories or the shot-time winds, but with typical wind changes and possible channelling effects in the lower levels, this discrepancy is not surprising.

Because of the low levels of radioactivity detected relative to background radiation, there is little confidence in the off-site fallout analysis.

2 mr/hr AT H+1



0 5 10 20 30 40 50
STATUTE MILES



MORA (1500 FT BALLOON) MAP B

H-HR= 0605 PST 29 SEPT 1958

CLOUD TOP- 18,500 FT. M.S.L

RESIDUAL GAMMA RADIATION
MR/HR AT H+1 HOUR

- LEGEND -

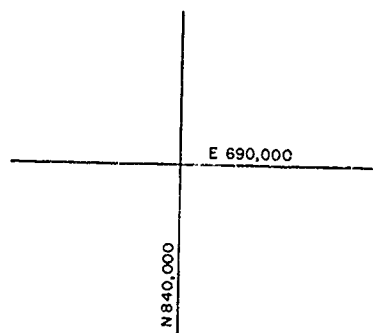
- DOSE RATE CONTOURS, MEASURED
- - - DOSE RATE CONTOURS, ESTIMATED
- - - TIME OF ARRIVAL, ESTIMATED, H+HOURS
- ELEVATION 5000 TO 7000 FEET
- ▨ ELEVATION 7000 TO 9000 FEET
- ▩ ELEVATION MORE THAN 9000 FEET
- ROAD (THICK LINE INDICATES MONITORED SECTION)

REMARKS

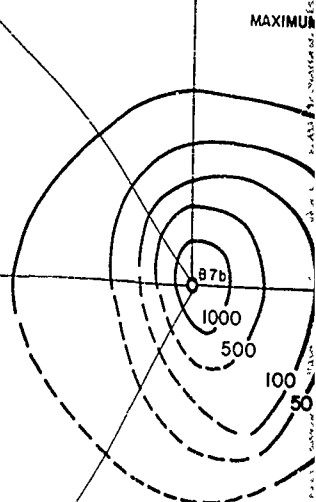
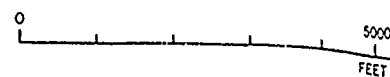
The on-site fallout from the Bldgo event was relatively
 mented and the pattern presented is consistent with the

MERCURY HIGHWAY

BJY

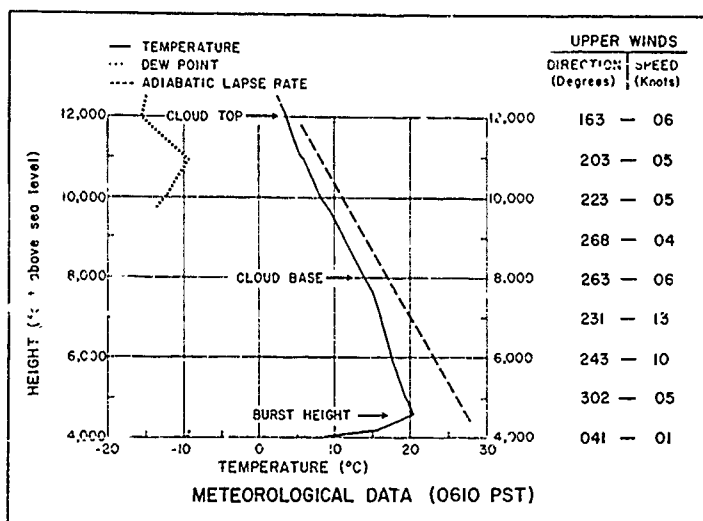


N →

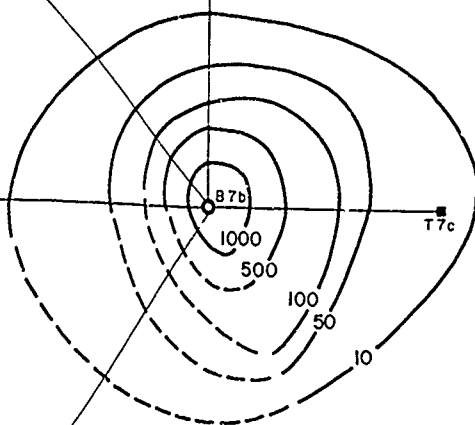


REMARKS

The on-site fallout from the Hidalgo event was relatively well documented and the pattern presented is considered to be fairly reliable



MAXIMUM AT GZ ~ 3 R/HR AT H+1



5000
 FLET
 10,000

HIDALGO (377 FT BALLOON) MAP A

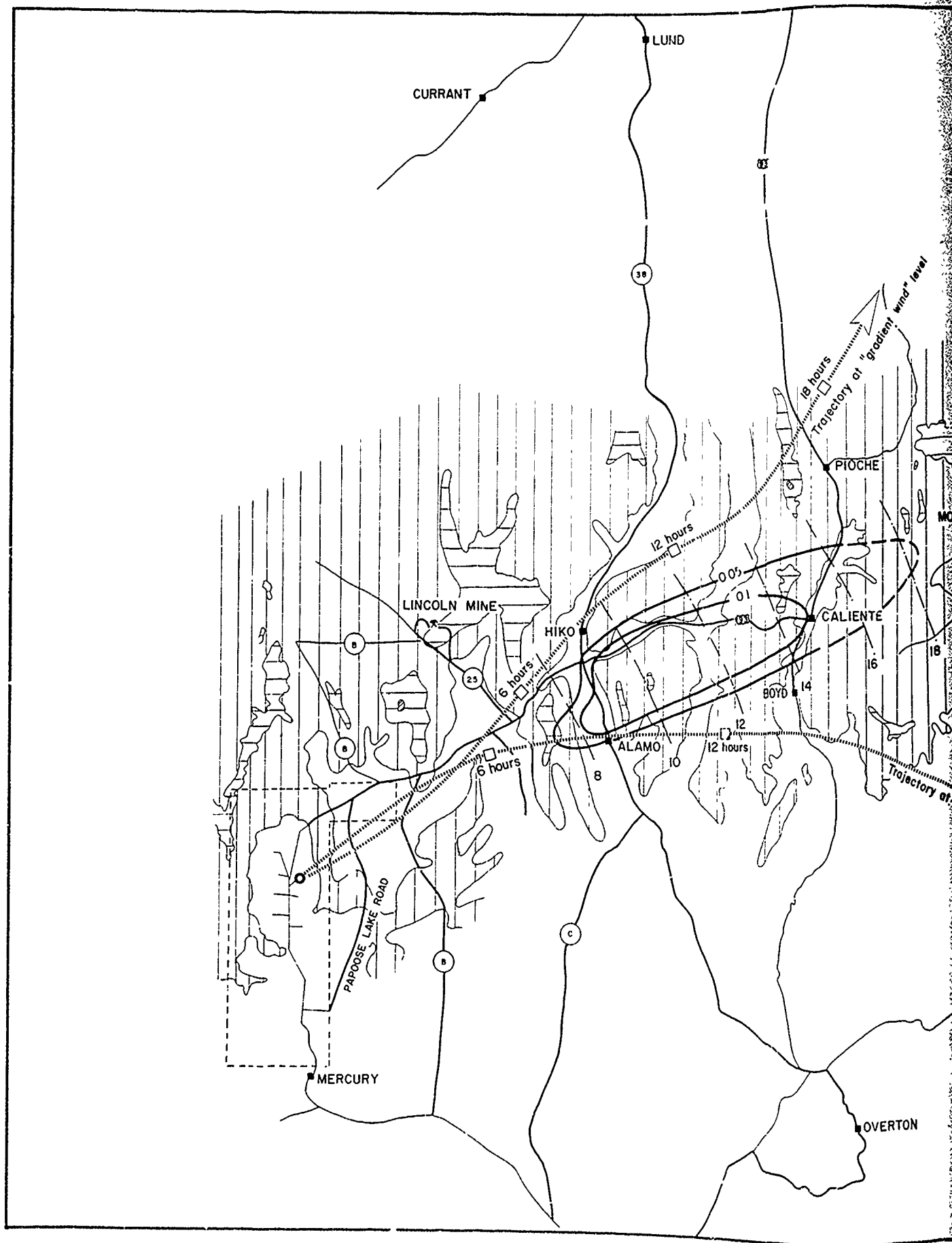
H-HR= 0610 PST 5 OCT 1958

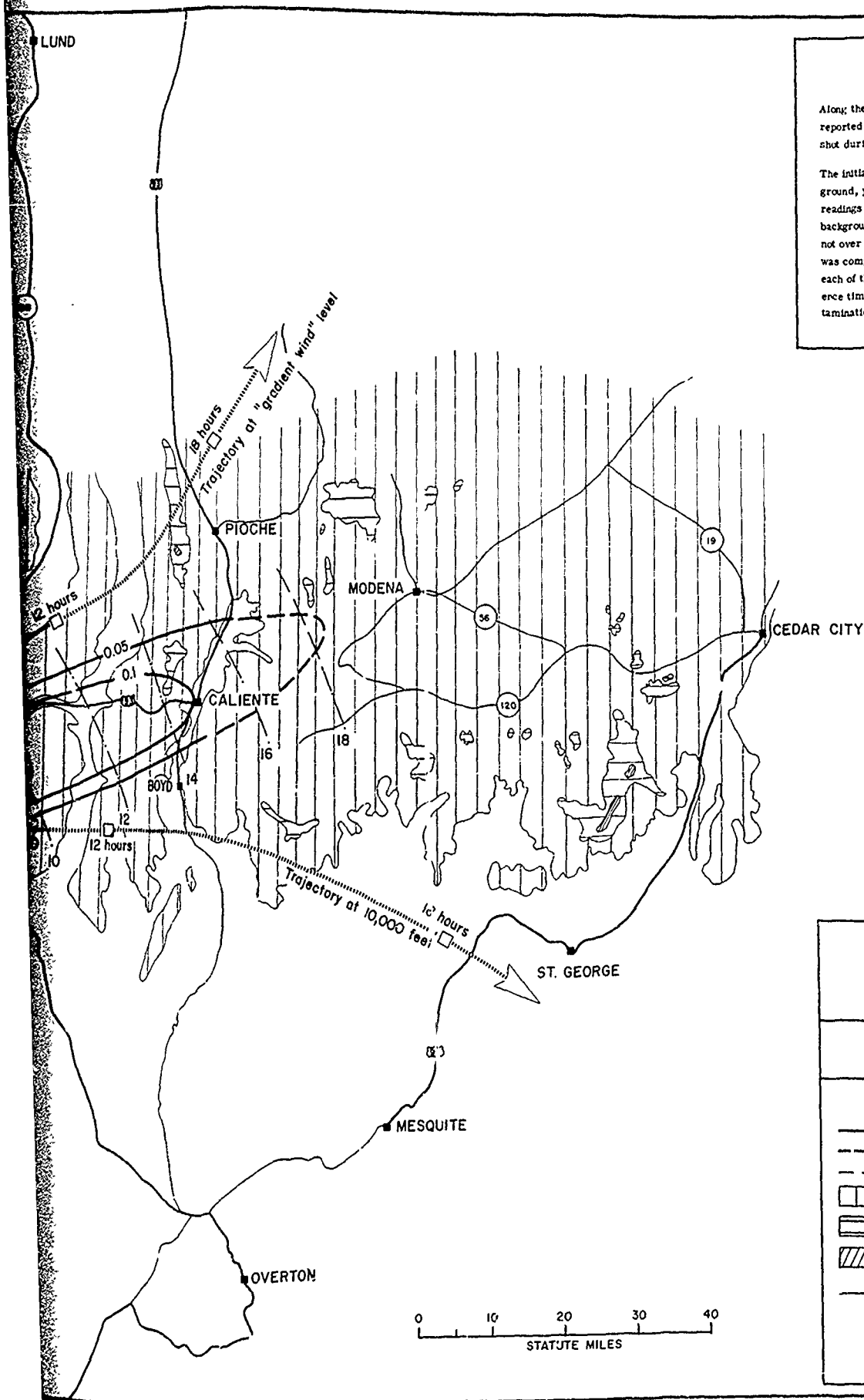
CLOUD TOP-12,000 FT MSL

RESIDUAL GAMMA RADIATION
 MR/HR AT H+1 HOUR

— LEGEND —

- DOSE RATE CONTOURS, MEASURED
- - - DOSE RATE CONTOURS, ESTIMATED





REMARKS

Along the Papoose Lake Road and Road "B" there was some activity reported which is attributed to residual contamination from the Smoky shot during Operation Plumbbob.

The initial survey to the northeast did not reveal any activity above background, yet on the next day (approximately 24 hours after shot time) readings in the Hiko-Alamo-Caliente area indicated activity 2 to 4 times background levels. The trajectories indicated that the nuclear cloud was not over this area before the initial survey but arrived after the survey was completed. The background value, therefore, was subtracted from each of the D-1 readings before their conversion to the common reference time. Because of the low levels of activity and background contamination, there is not too high a confidence in this analysis.

HIDALGO (377 FT BALLOON) MAP B

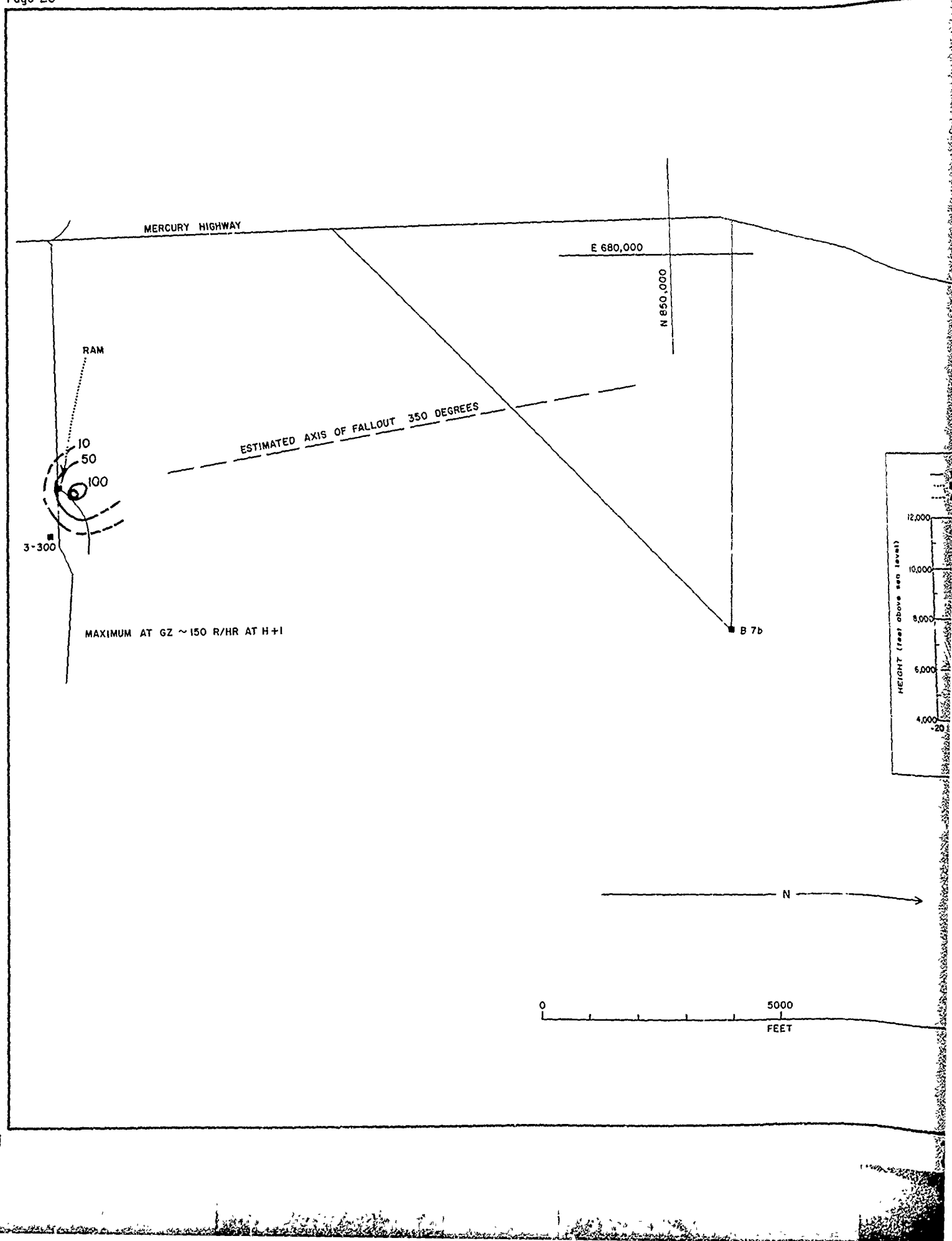
H-HR= 0610 PST 5 OCT 1958

CLOUD TOP- 12,000 FT. MSL

RESIDUAL GAMMA RADIATION
MR/HR AT H+12 HOURS

- LEGEND -

- DOSE RATE CONTOURS, MEASURED
- - - DOSE RATE CONTOURS, ESTIMATED
- - - TIME OF ARRIVAL, ESTIMATED, H+HOURS
- ELEVATION 5000 TO 7000 FEET
- ELEVATION 7000 TO 9000 FEET
- ELEVATION MORE THAN 9000 FEET
- ROAD (THICK LINE INDICATES MONITORED SECTION)



REMARKS

Based on the shot time wind run the Colfax fallout should have had a hot-line bearing of about 350 degrees. There was some activity reported around Area 9, as indicated on the map. Elsewhere there was insufficient monitoring information from which to draw a complete pattern.

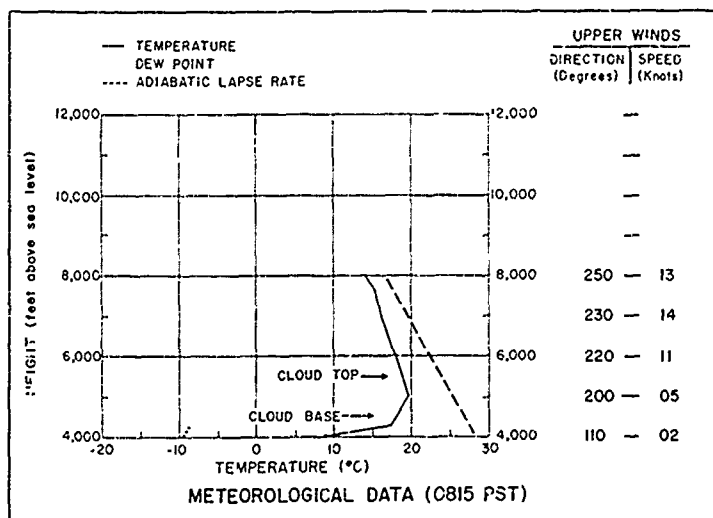
The only activity above background reported by the off-site monitor was at about 1/2 mile north of Gate 585 on the Groom Lake Road. This was about 0.3 m/hr when converted to H+1.

28 mr/hr AT H+1
9-800

9-300
16 mr/hr AT H+1

B-90

12 mr/hr AT H+1
9-802



COLFAX (350 WELL) MAP A

H-HR= 0815 PST 5 OCT. 1958

CLOUD TOP- 5500 FT M.S.L.

RESIDUAL GAMMA RADIATION

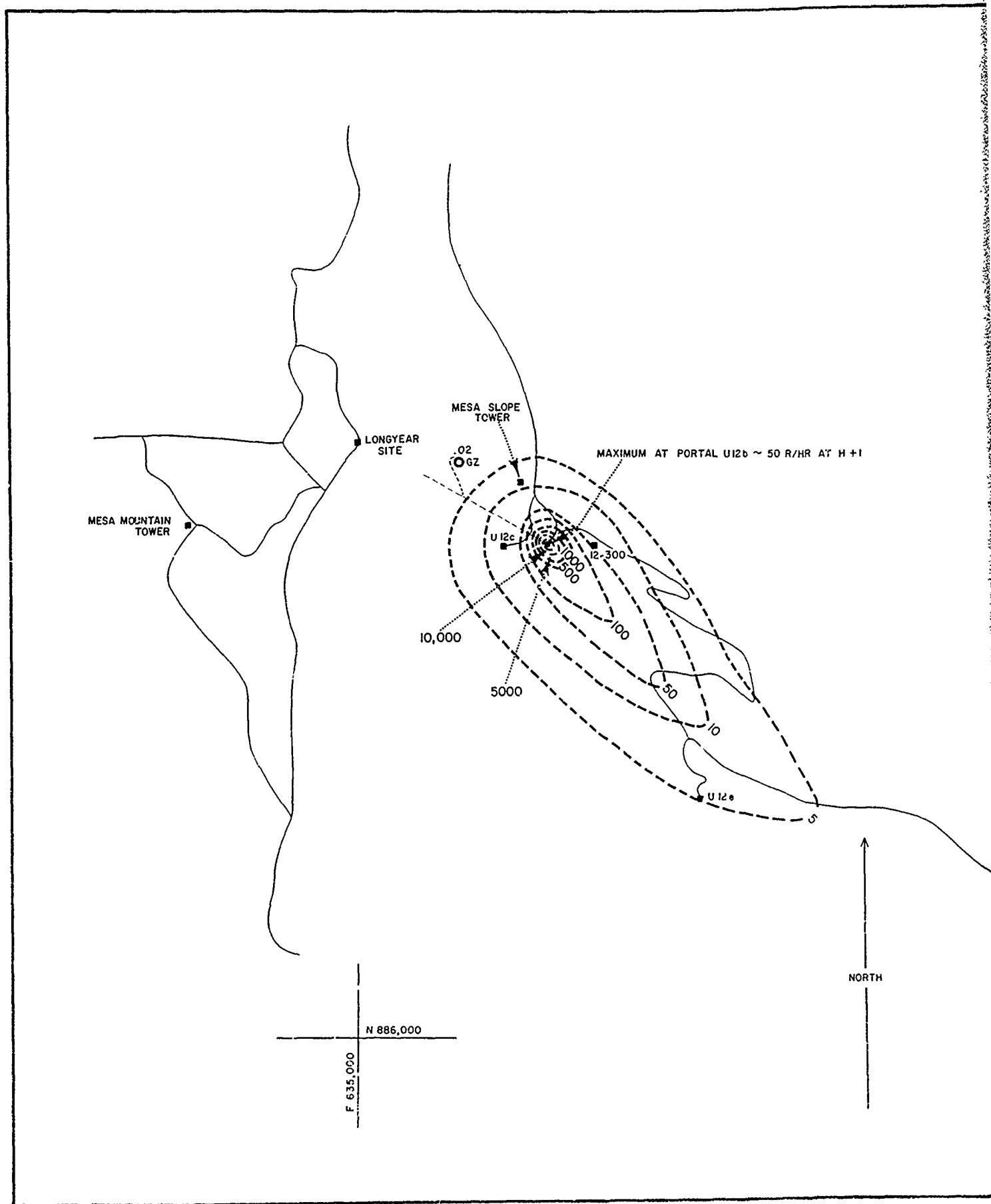
MR/HR AT H+1 HOUR

— LEGEND —

- DOSE RATE CONTOURS, MEASURED
- DOSE RATE CONTOURS, ESTIMATED

5000
FEET
10,000

N



REMARKS

There was only a minor amount of venting through the tunnel mouth (located at the side of the mesa slope at an elevation of 6,650 feet m.s.l.) and no organized cloud was formed. Strong west winds above the mesa slope (see table below) prevented the formation of the normal afternoon upslope (northeast) winds.

The short-time winds at the Mesa Mountain tower were from the west while the winds at the slope station were from the north. The slope winds indicated that the activity, which was confined to the lower layers, should have been transported toward the south. A channeling effect due to the canyon, oriented northwest-southeast, between Portals B and E transported the debris toward the southeast.

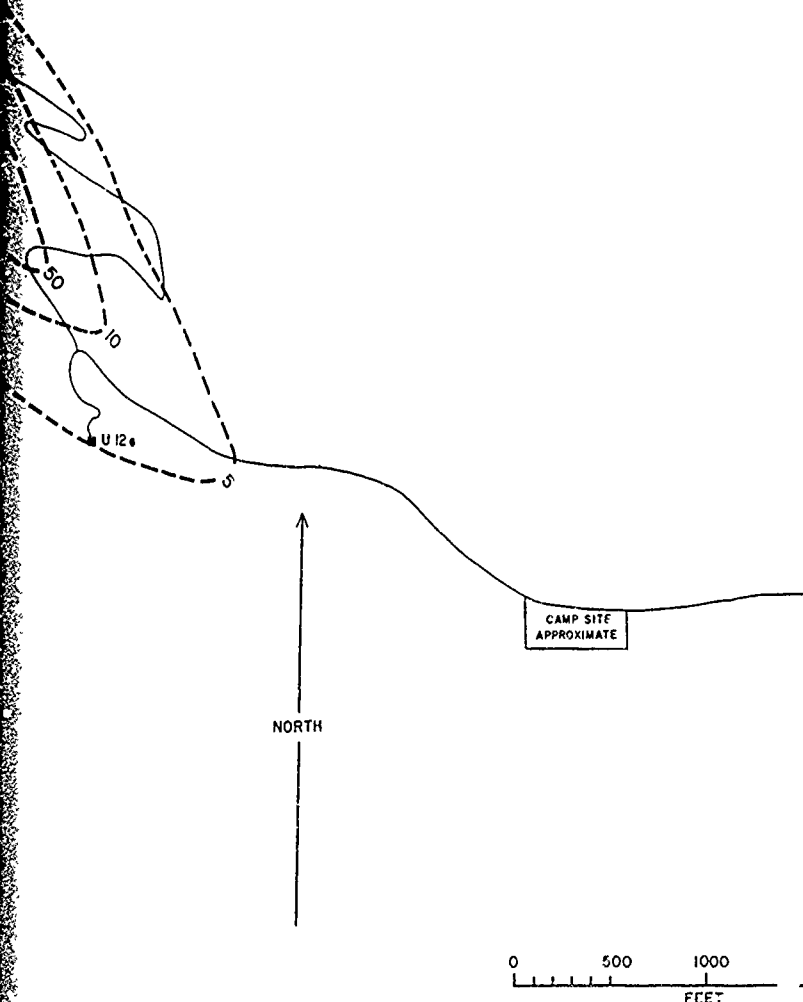
The activity isolines shown are very uncertain. It is believed that there was some true fallout downwind from the portals, but that the radiation reported was primarily airborne activity in gaseous or very small particulate form. At several places, such as the B, C, and E portals, and at the Longyear Site, a rapid drop in intensity in a very short time period was recorded, indicating that the activity was most likely drifting by in the air. An attempt was made to normalize the activity to a common reference time, but because of the uncertainty as to what fraction of the activity was airborne and what was true fallout, the isolines were dashed and there is no degree of confidence in this pattern. For this reason no attempt should be made to integrate this pattern to estimate the fraction of the total activity which came down as close-in fallout.

No activity above background was detected off-site.

15 Minute Average Winds

9-foot Mesa Slope Tower (Surface Elevation-6725 feet m.s.l.)			100-foot Mesa Mountain Tower (Surface Elevation-7465 feet m.s.l.)	
Time (PST)	Direction (degrees)	Speed (m.p.h.)	Direction (degrees)	Speed (m.p.h.)
1145-1200	360	11	300	11
1245-1300	360	08	290	15
1345-1400	360	09	270	17
1445-1500	360	09	265	17
1545-1600	360	06	270	18

AT PORTAL U120 ~ 50 R/HR AT H+1



TAMALPAIS (TUNNEL) MAP A

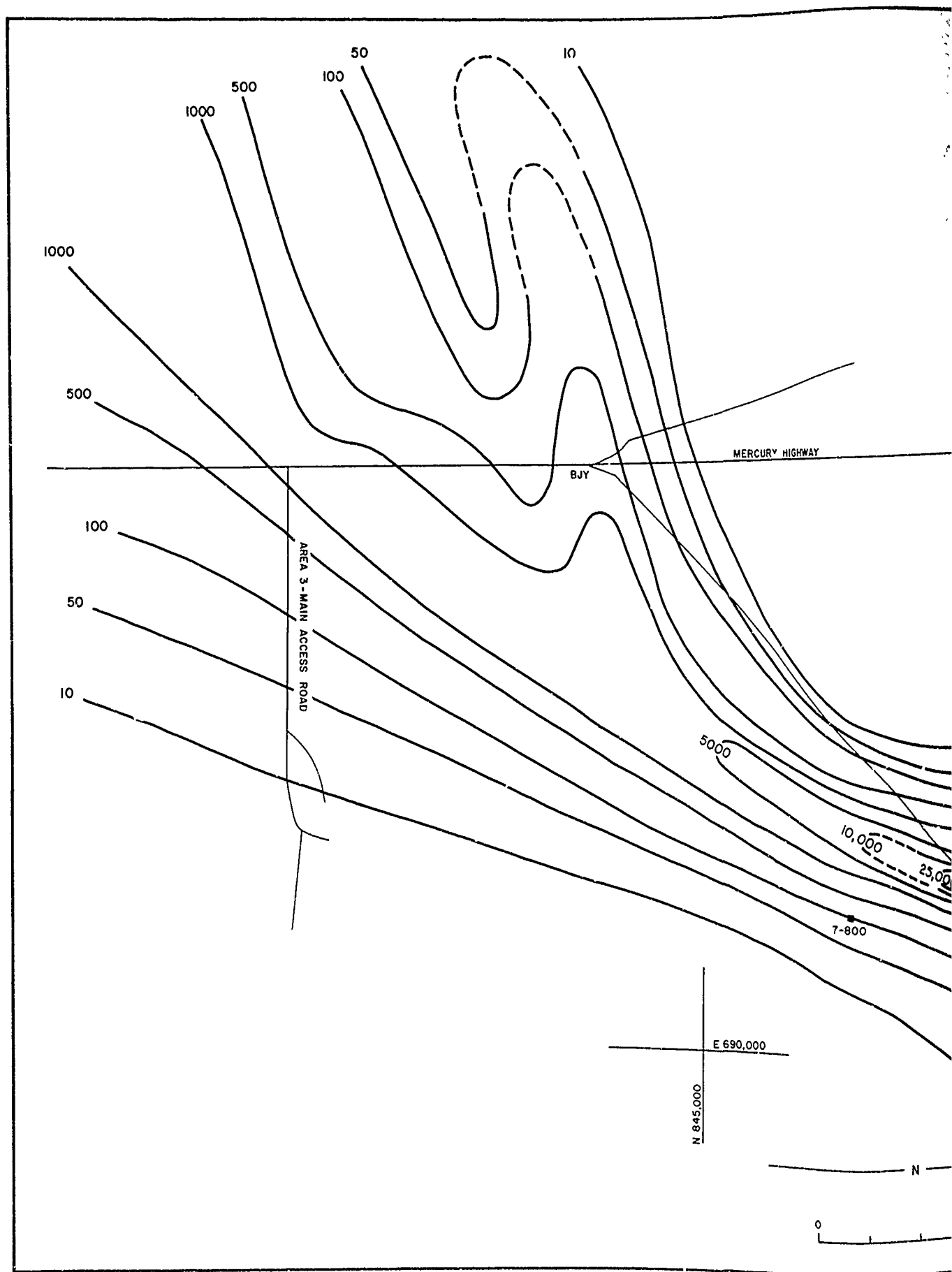
H-HR- 1400 PST 8 OCT 1958

CLOUD TOP- LOW DIFFUSE CLOUD

RESIDUAL GAMMA RADIATION
MR/HR AT H+1 HOUR

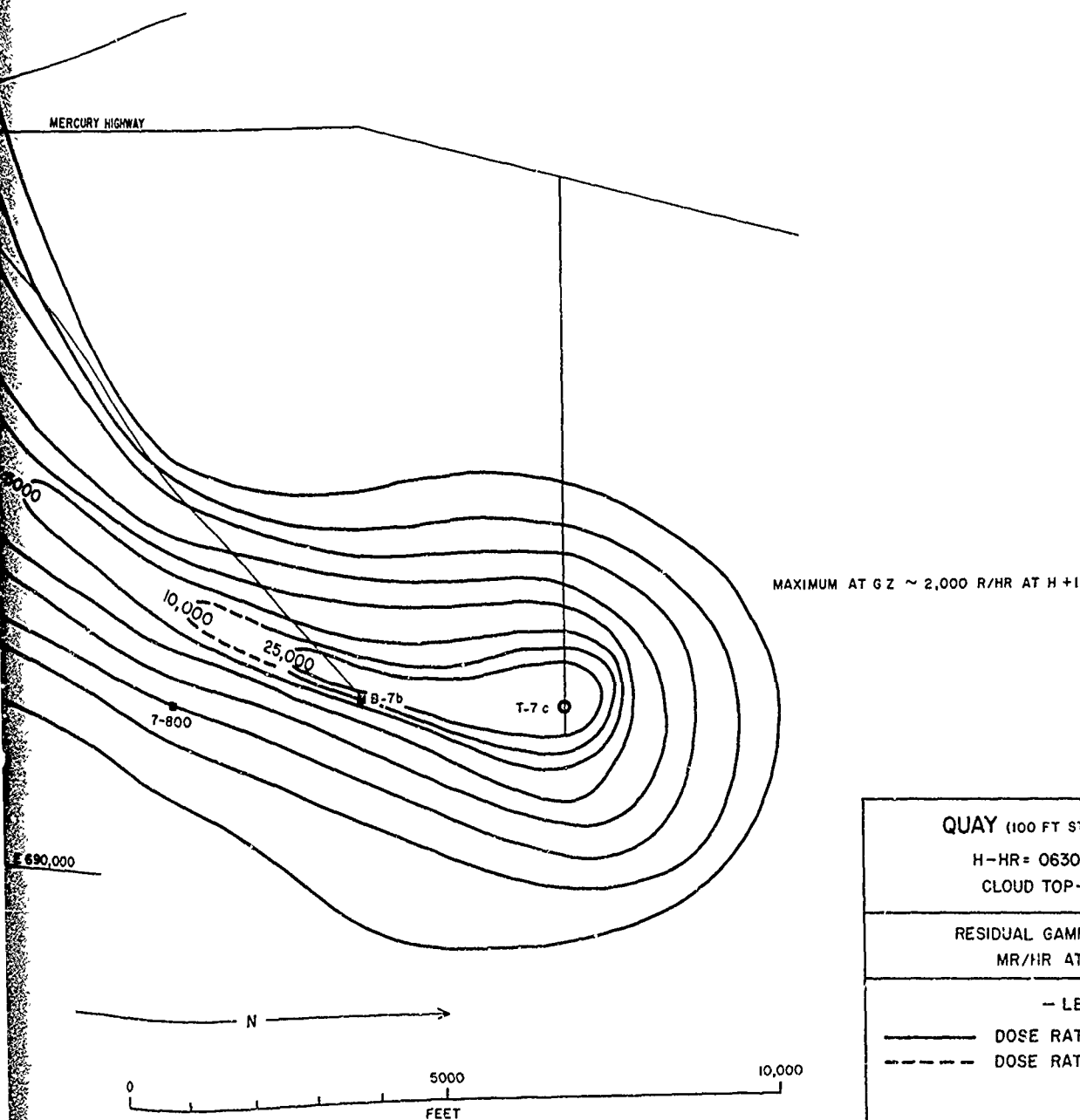
- LEGEND -

- DOSE RATE CONTOURS, MEASURED
- DOSE RATE CONTOURS, ESTIMATED



REMARKS

The on-site fallout from the Quay event was well documented and the pattern is considered to be fairly reliable. The portion of the pattern which was interpolated (indicated by the dashed isolines) can only be an approximation in the absence of measurements.



QUAY (100 FT STEEL TOWER) MAP A

H-HR = 0630 PST 10 OCT. 1958

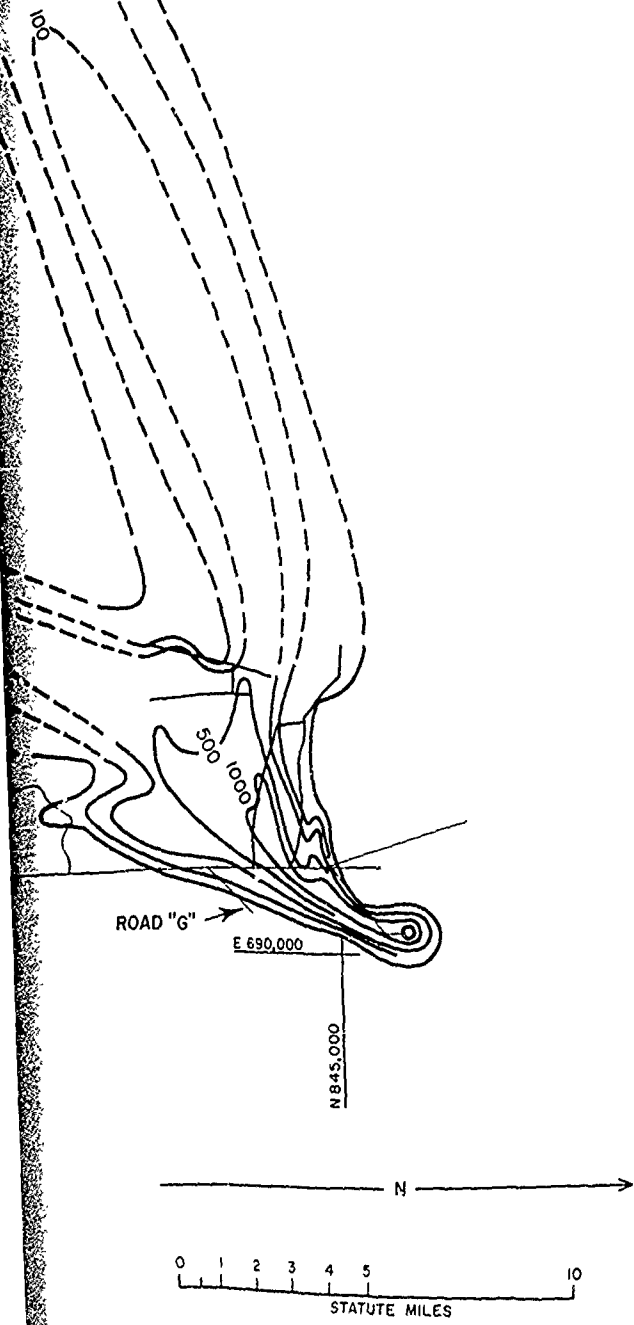
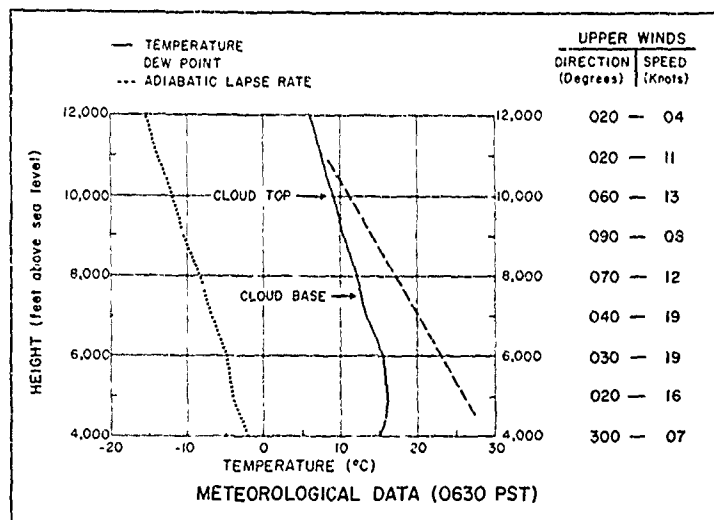
CLOUD TOP - 10,000 FT. M.S.L.

RESIDUAL GAMMA RADIATION
MR/HR AT H+1 HOUR

- LEGEND -

- DOSE RATE CONTOURS, MEASURED
----- DOSE RATE CONTOURS, ESTIMATED





QUAY (100 FT. STEEL TOWER) MAP B

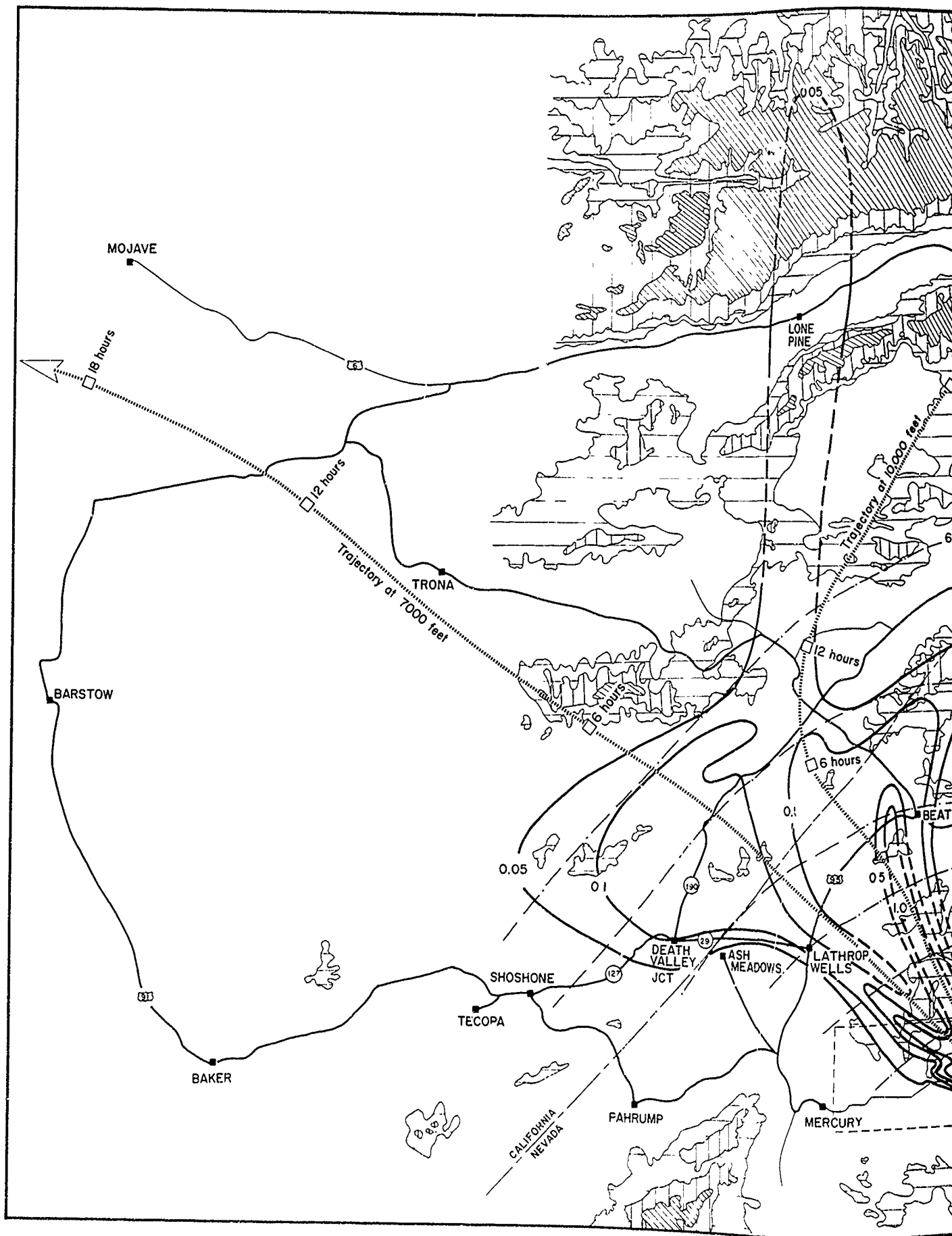
H-HR = 0630 PST 10 OCT 1958

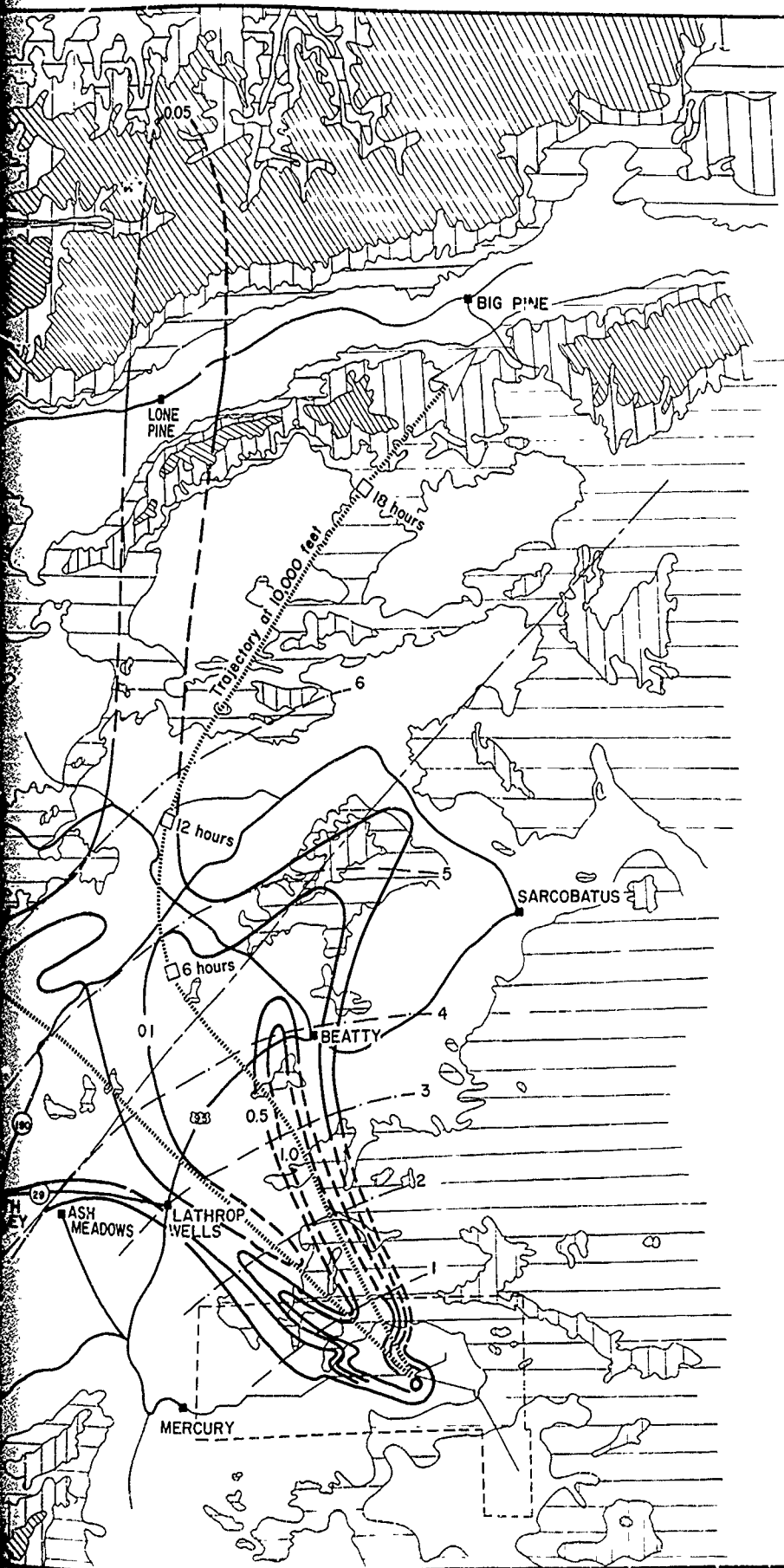
CLOUD TOP - 10,000 FT M.S.L.

RESIDUAL GAMMA RADIATION
MR/HR AT H + 1 HOUR

- LEGEND -

- DOSE RATE CONTOURS, MEASURED
- - - DOSE RATE CONTOURS, ESTIMATED





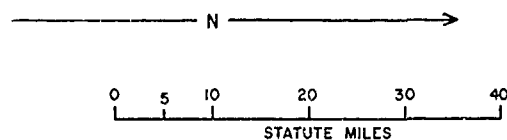
REMARKS

Since the winds were light, with several small cyclonic and anticyclonic cells in the area, there is considerable doubt as to the true path of the trajectories.

The air sampling of beta activity indicated above-background readings at Beatty, Goldfield, Tonopah and Warm Springs. These results indicated that at least a portion of the cloud had a northward trajectory from Beatty towards Tonopah and then probably veered toward Warm Springs.

There were no monitor runs north of Sarcobatus, but it is believed that the fallout north of this point was light since the activity would have been spread over a relatively large area. Therefore, the pattern was not extended toward the north, even though the beta readings indicated this to be the path of the activity.

Since this event was well documented off-site, the pattern is considered to be reliable.



QUAY (100 FT STEEL TOWER) MAP C

H-HR: 0630 PST 10 OCT 1958

CLOUD TOP- 10,000 FT MSL.

RESIDUAL GAMMA RADIATION

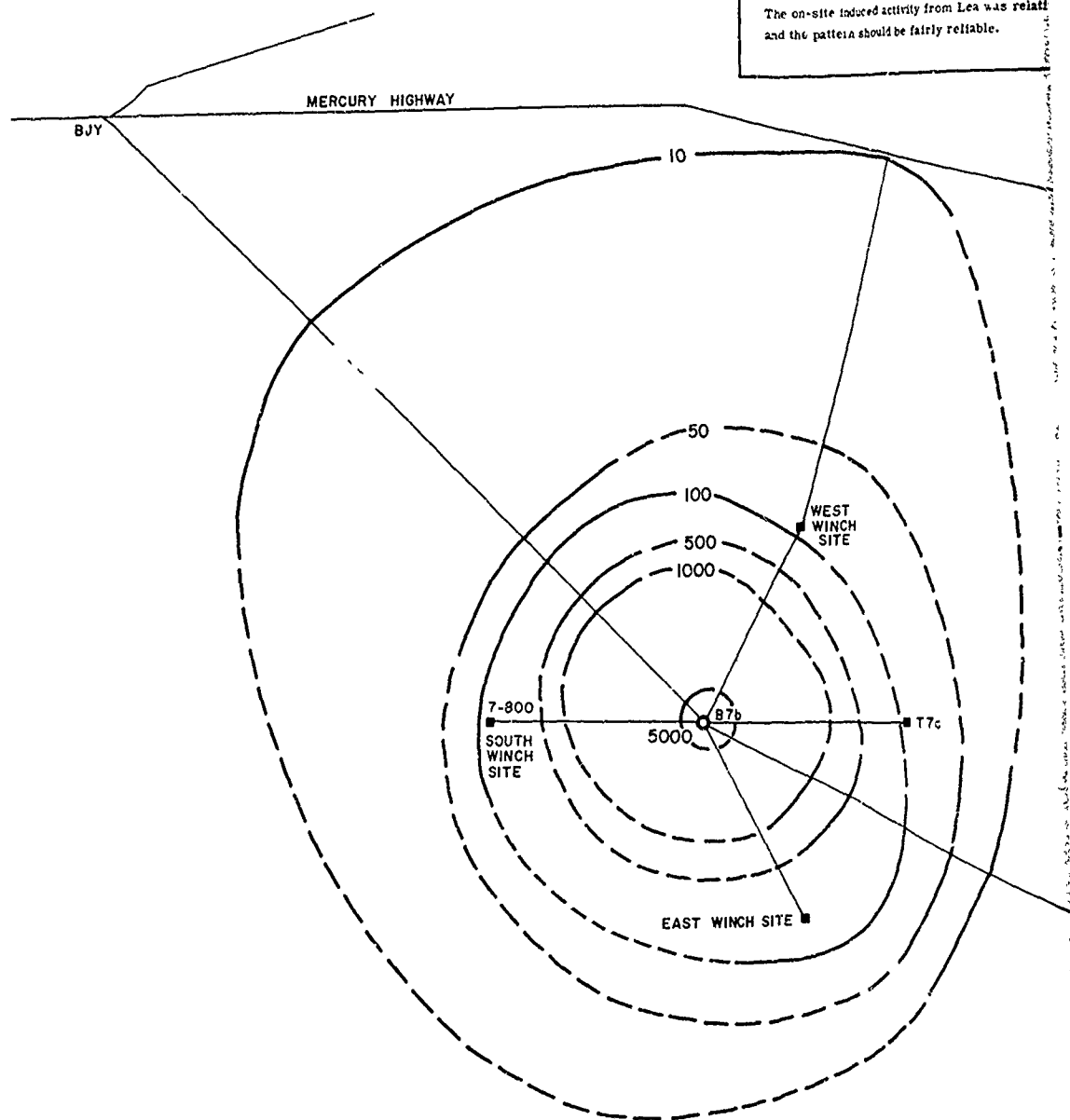
MR/HR AT H+12 HOURS

- LEGEND -

- DOSE RATE CONTOURS, MEASURED
- - - - DOSE RATE CONTOURS, ESTIMATED
- - - - TIME OF ARRIVAL, ESTIMATED, H+HOURS
- ▨ ELEVATION 5000 TO 7000 FEET
- ▤ ELEVATION 7000 TO 9000 FEET
- ▧ ELEVATION MORE THAN 9000 FEET
- ROAD (THICK LINE INDICATES MONITORED SECTION)

REMARKS

The on-site induced activity from Lea was relatively low and the pattern should be fairly reliable.

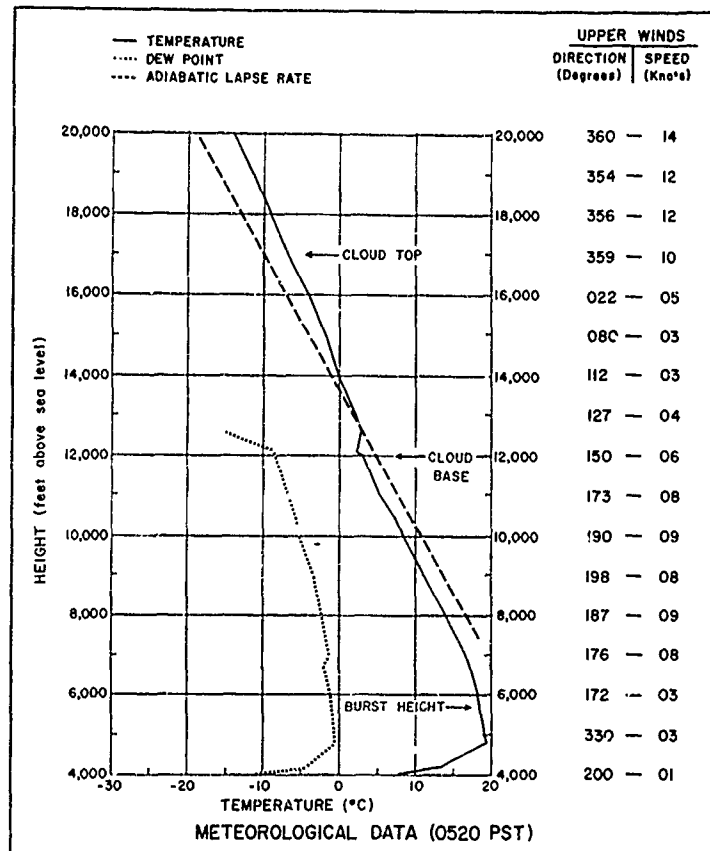
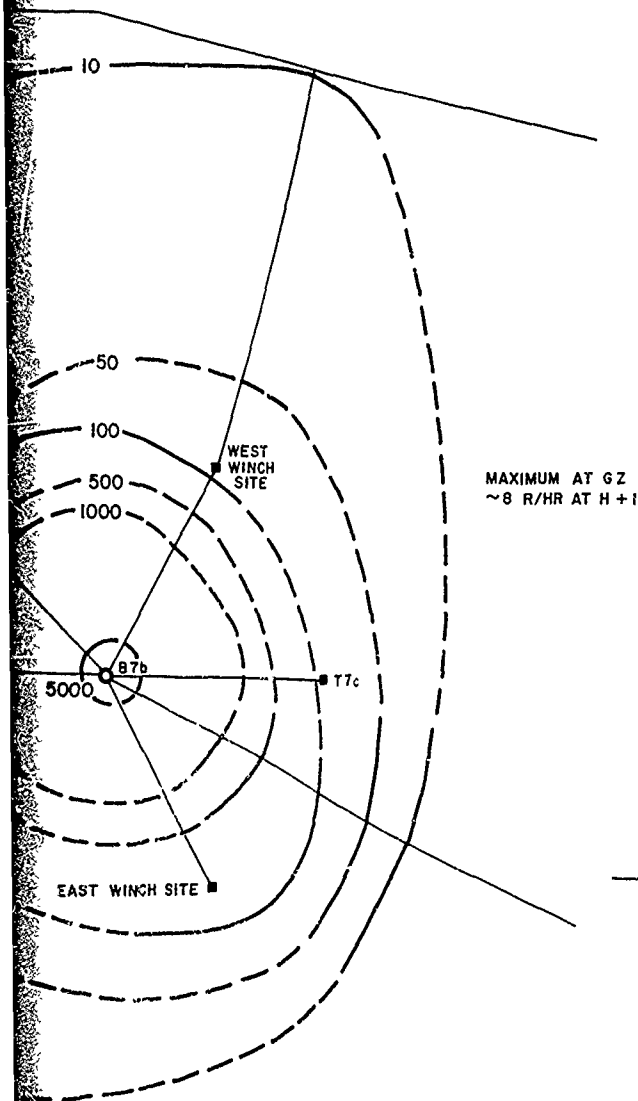


N

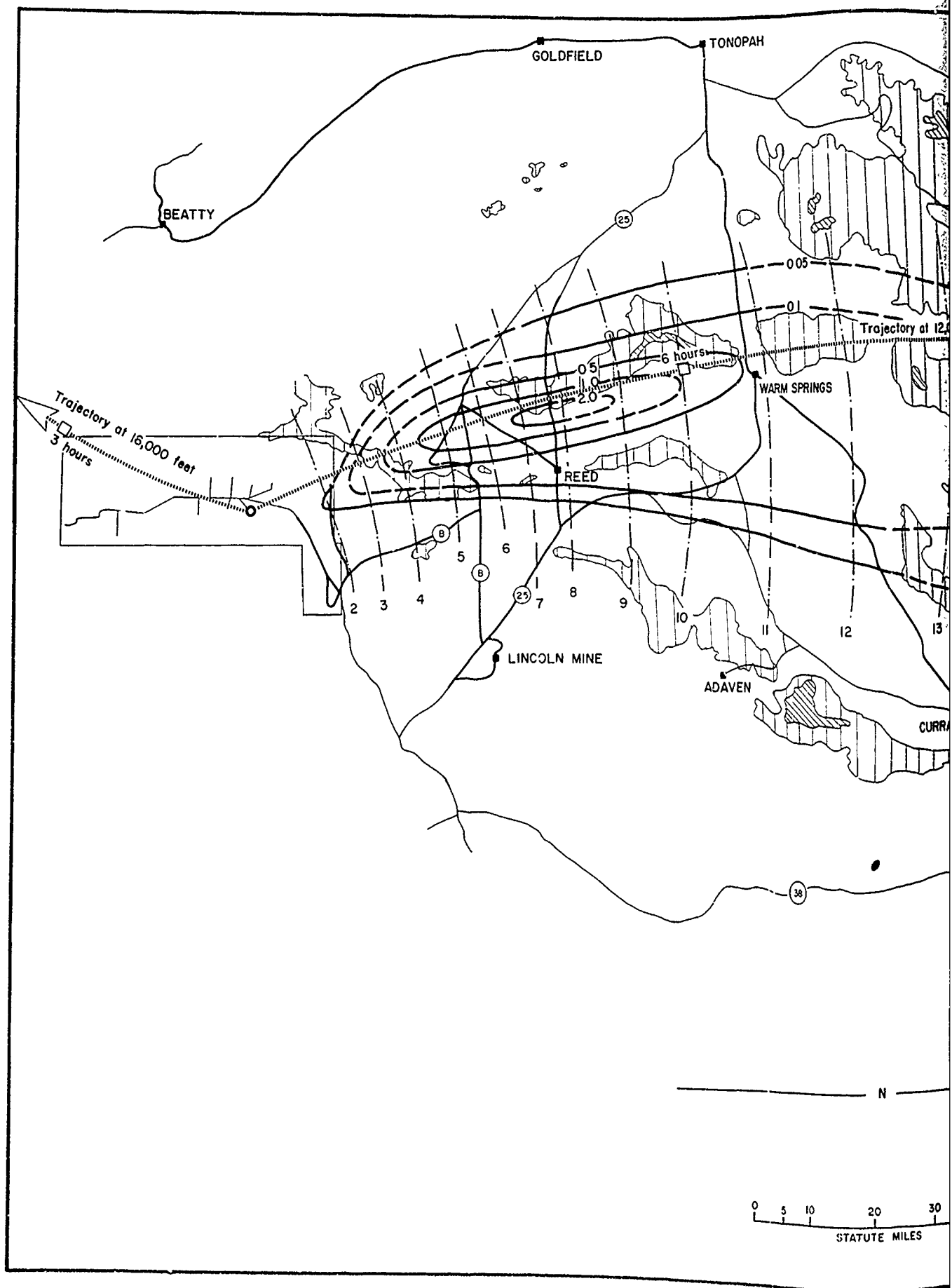
0 5,000 10,000
FEET

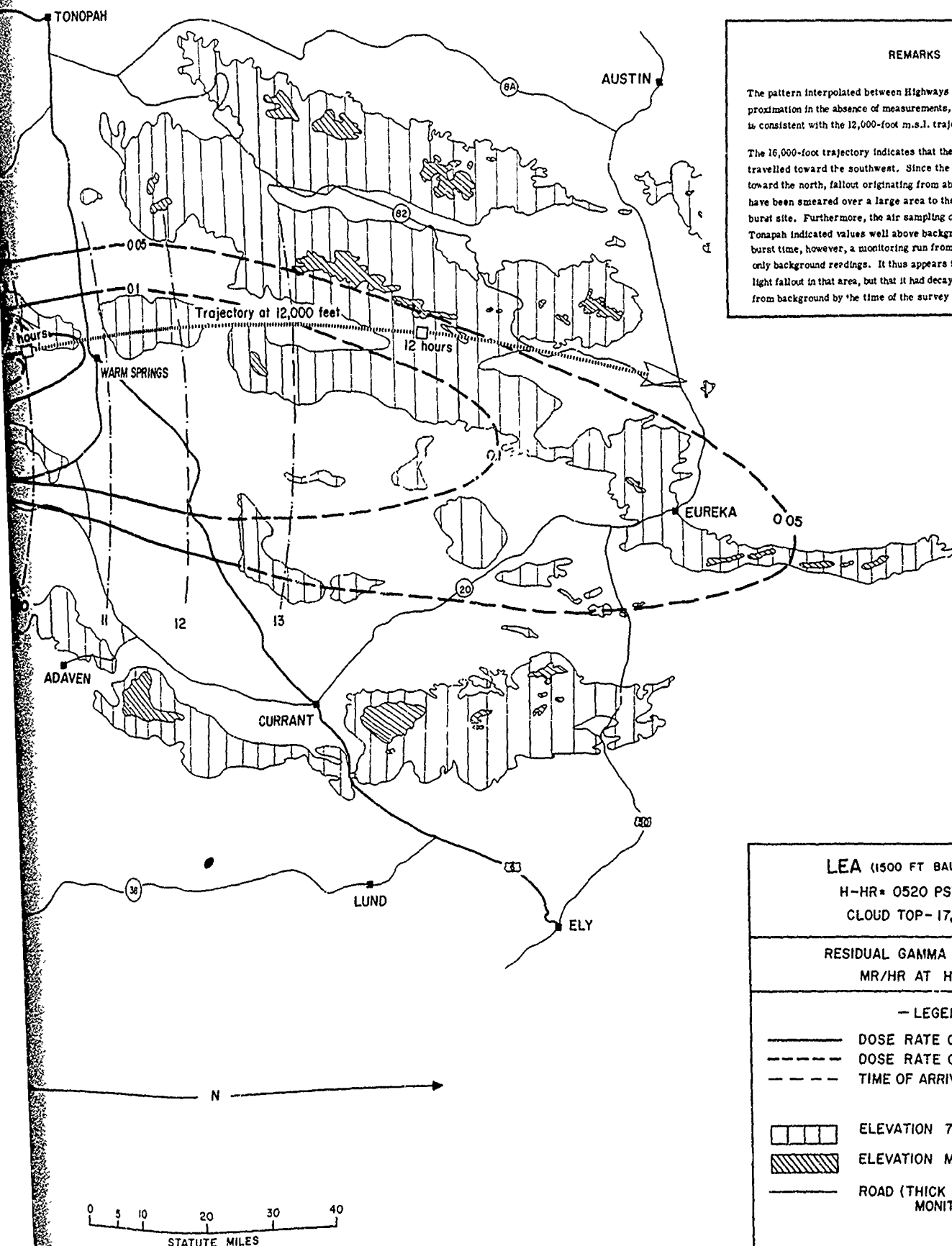
REMARKS

The on-site induced activity from Lea was relatively well documented and the pattern should be fairly reliable.



LEA (1500 FT BALLOON) MAP A
H-HR= 0520 PST 13 OCT. 1958
CLOUD TOP- 17,000 FT. M.S.L.
RESIDUAL GAMMA RADIATION
MR/HR AT H+1 HOUR
— LEGEND —
———— DOSE RATE CONTOURS, MEASURED
----- DOSE RATE CONTOURS, ESTIMATED





REMARKS

The pattern interpolated between Highways 6 and 50 can only be an approximation in the absence of measurements, but its orientation, at least, is consistent with the 12,000-foot m.s.l. trajectory.




The 16,000-foot trajectory indicates that the cloud at that level initially travelled toward the southwest. Since the winds at lower levels were toward the north, fallout originating from about 16,000 feet m.s.l. would have been smeared over a large area to the west and northwest of the burst site. Furthermore, the air sampling of beta activity at Beatty and Tonopah indicated values well above background. About 30 hours after burst time, however, a monitoring run from Beatty to Tonopah reported only background readings. It thus appears that there probably was very light fallout in that area, but that it had decayed to levels indistinguishable from background by the time of the survey.

LEA (1500 FT BALLOON) MAP B
H-HR= 0520 PST 13 OCT. 1958
CLOUD TOP-17,000 FT. M.S.L.

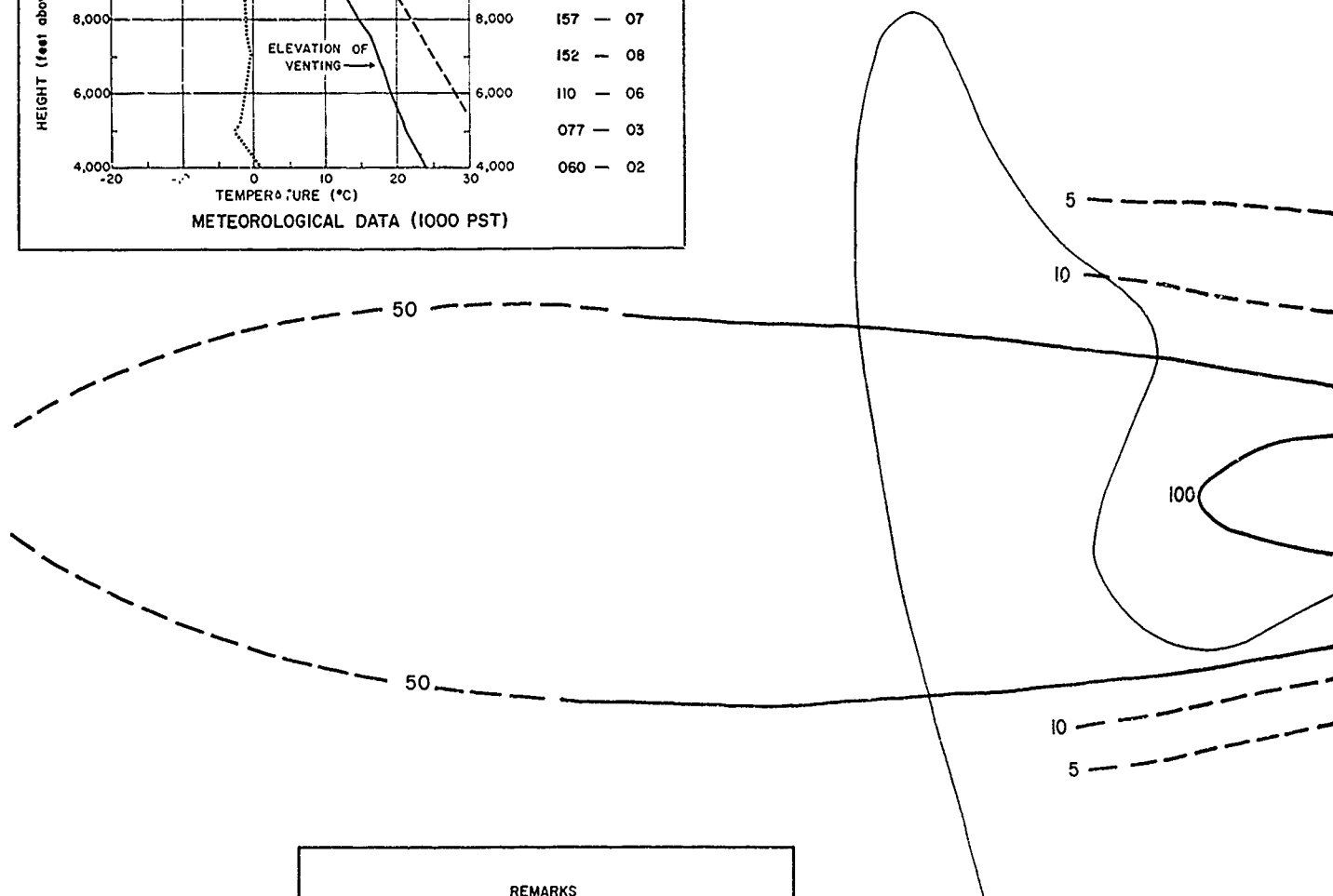
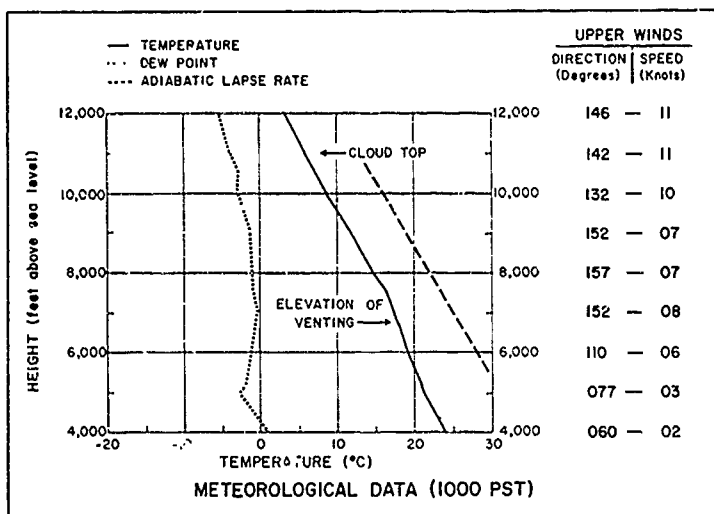
RESIDUAL GAMMA RADIATION
MR/HR AT H+12 HOURS

- LEGEND -

- | | |
|-----------|-------------------------------------|
| ----- | DOSE RATE CONTOURS, MEASURED |
| - - - - - | DOSE RATE CONTOURS, ESTIMATED |
| - - - - - | TIME OF ARRIVAL, ESTIMATED. H+HOURS |

-  ELEVATION 7000 TO 9000 FEET
 ELEVATION MORE THAN 9000 FEET
 ROAD (THICK LINE INDICATES MONITORED SECTION)

21



REMARKS

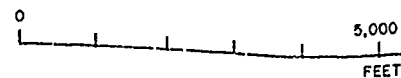
The Neptune explosion vented through the mesa slope at an elevation of about 6,800 feet. The cloud rose to about 11,000 feet m.s.l. The winds at the mesa mountain tower indicated that the lower layers of the cloud would be transported on a bearing of 310 degrees. The actual fallout was centered on a bearing of about 300 degrees. This would imply that the direction was fairly constant between the level of the top of the cloud and that part which passed just above the mesa.

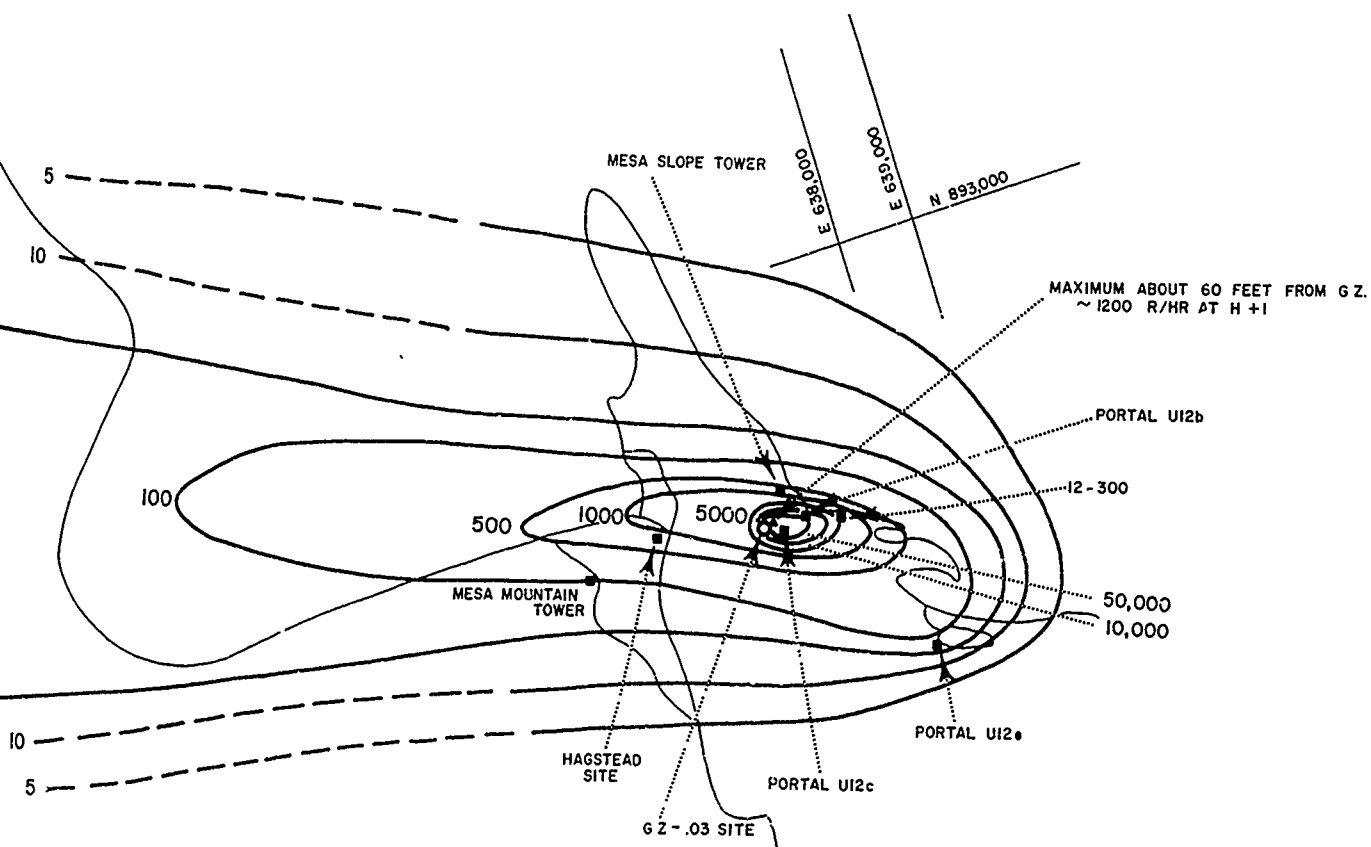
The pattern for that part of the mesa which was monitored, as indicated by the solid lines, is considered fairly reliable.

No activity above background levels was reported off site.

15 Minute Average Winds

9-foot Mesa Slope Tower (Surface Elevation-6725 feet m.s.l.)			100-foot Mesa Mountain Tower (Surface Elevation-7465 feet m.s.l.)	
Time (PST)	Direction (degrees)	Speed (m.p.h.)	Direction (degrees)	Speed (m.p.h.)
0745-0800	040	05	180	02
0845-0900	040	07	110	02
0945-1000	045	08	130	06
1045-1100	050	10	Missing	Missing
1145-1200	060	10	Missing	Missing



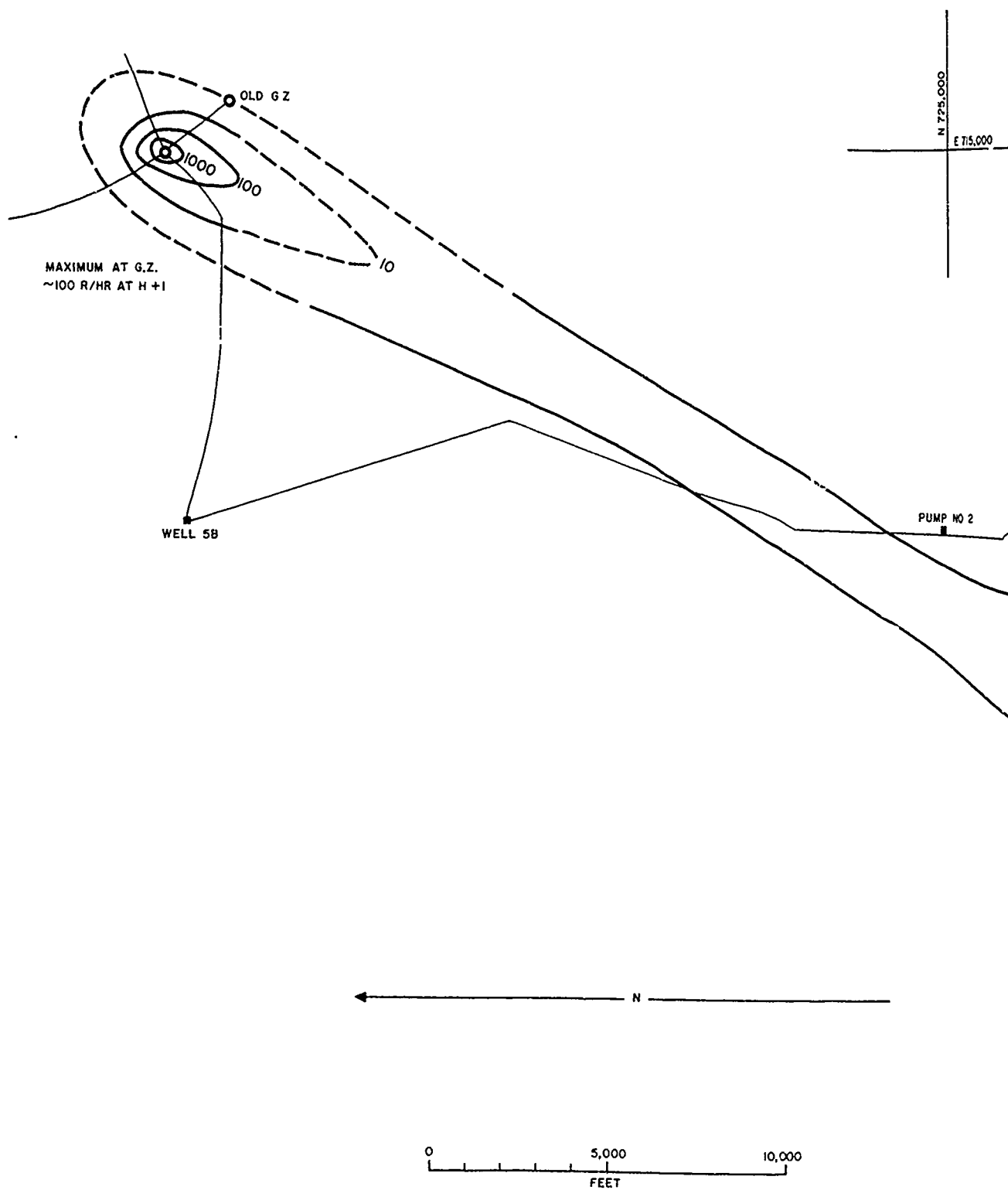


NEPTUNE (TUNNEL) MAP A
 H-HR= 1000 PST 14 OCT. 1958
 CLOUD TOP- 11,000 FT M.S.L.

RESIDUAL GAMMA RADIATION
 MR/HR AT H+1 HOUR

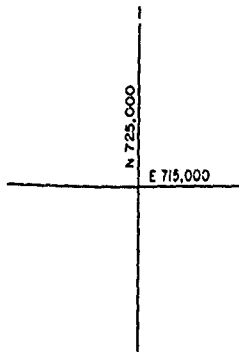
- LEGEND -

———— DOSE RATE CONTOURS, MEASURED
 - - - - - DOSE RATE CONTOURS, ESTIMATED



REMARKS

The downwind extent of the 10 mr/hr line is uncertain but the rest of the pattern is considered to be reliable.



PUMP NO 2

PUMP NO 3

HAMILTON (50 FT WOOD TOWER) MAP A

H-HR= 0800 PST 15 OCT 1958

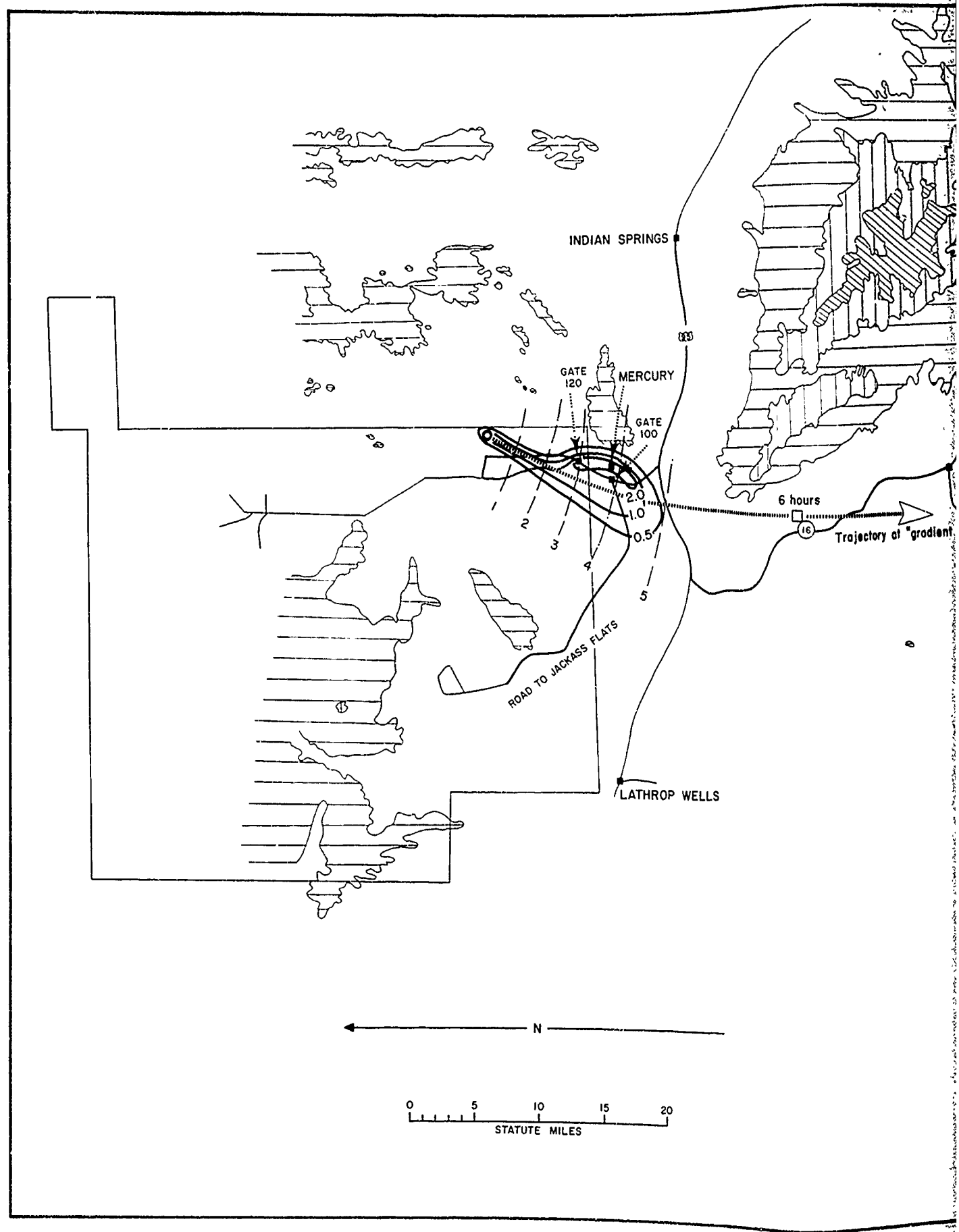
CLOUD TOP-- 6,000 FT M.S.L.

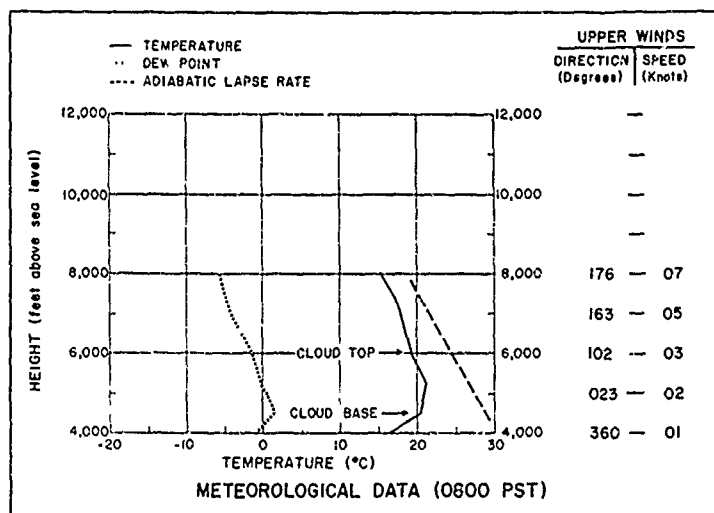
RESIDUAL GAMMA RADIATION
MR/HR AT H + 1 HOUR

- LEGEND -

———— DOSE RATE CONTOURS, MEASURED
----- DOSE RATE CONTOURS, ESTIMATED

2





REMARKS

The representativeness of the temperature height curve shown with the meteorological data is questionable, since the elevation of the Hamilton site in Frenchman's Flat is 3,080 feet, about 800 feet below that of the Yucca Lake weather station where the temperature soundings were made. Also, because of the very low speeds and the influence of terrain, the winds reported may not be representative of those in Frenchman's Flat.

The gradient wind trajectory had a speed of about 4 knots while the mean wind speed from the surface to 6,000 feet m.s.l. was about 2 knots. As the cloud moved southward rather slowly, it gave moderate peaks of activity at Mercury as indicated in Figure 5.

This pattern was relatively well documented and is consistent with the wind analysis.

HAMILTON (50 FT WOOD TOWER) MAP B

H-HR = 0800 PST 15 OCT. 1958

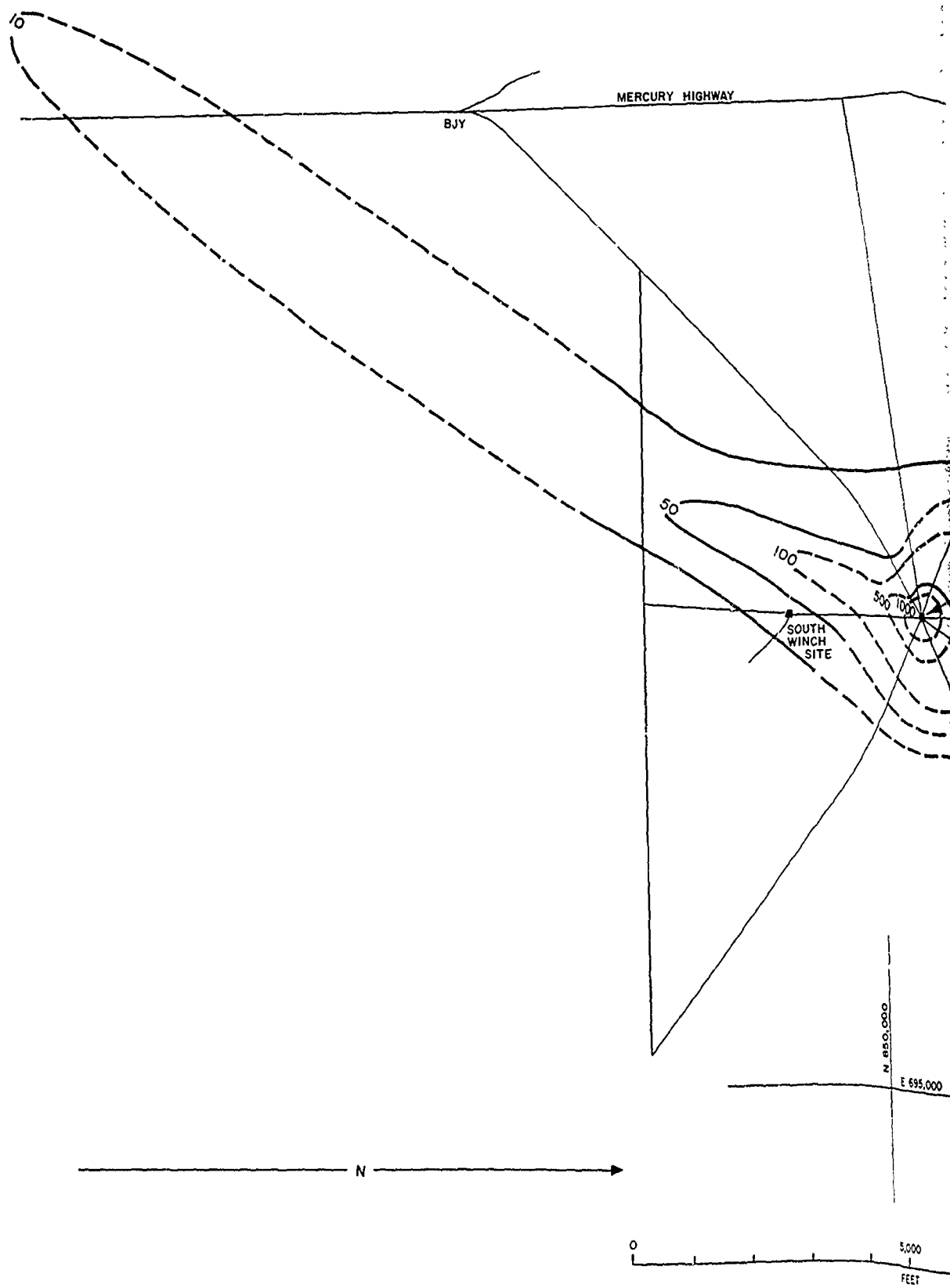
CLOUD TOP - 6,000 FT. M.S.L.

RESIDUAL GAMMA RADIATION

MR/HR AT H+1 HOUR

— LEGEND —

- DOSE RATE CONTOURS, MEASURED
- - - DOSE RATE CONTOURS, ESTIMATED
- - - TIME OF ARRIVAL, ESTIMATED, H+1 HOURS
- ▨ ELEVATION 5000 TO 7000 FEET
- ▩ ELEVATION 7000 TO 9000 FEET
- ▤ ELEVATION MORE THAN 9000 FEET
- ROAD (THICK LINE INDICATES MONITORED SECTION)



REMARKS

The 10 mr/hr isoline crossing the Mercury Highway south of the BTJ is rather uncertain. The cloud should have been over this area at about the time that some of the measurements were made. Therefore, what was being monitored may have been sky shine, induced activity, or a combination of both.

There is not too much confidence in this pattern since the downwind extent of most of the isolines is not known and the area to the east of ground zero was not monitored.

MAXIMUM AT G.Z. ~ 2 R/HR AT H + 1

WEST WINCH SITE

100

500

1000

7-300

T7c

SOUTH WINCH SITE

FAST WINCH SITE

N 850,000

E 695,000

5,000

FEET

10,000

DOÑA ANA (450 FT BALLOON) MAP A

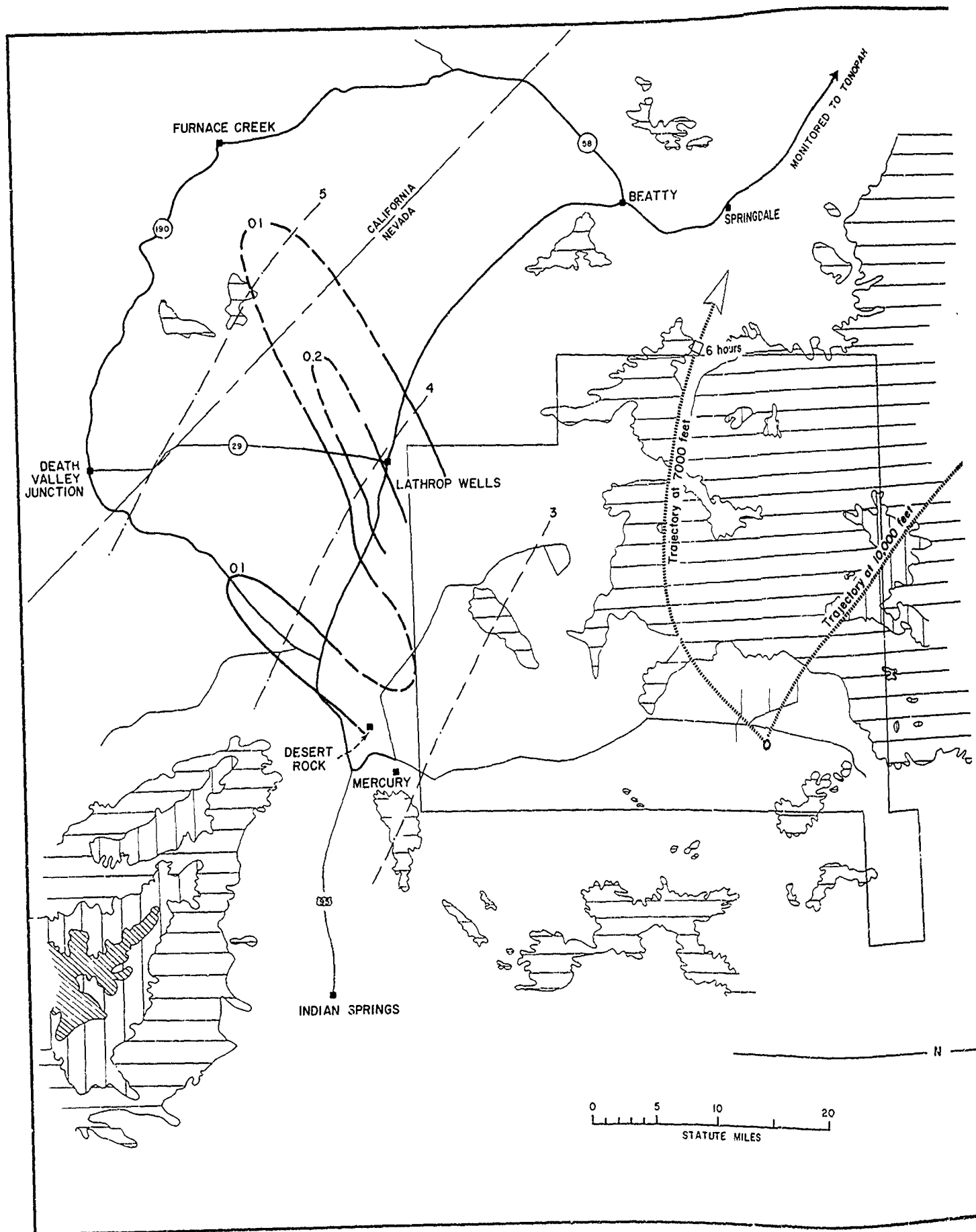
H-HR = 0620 PST 16 OCT. 1958

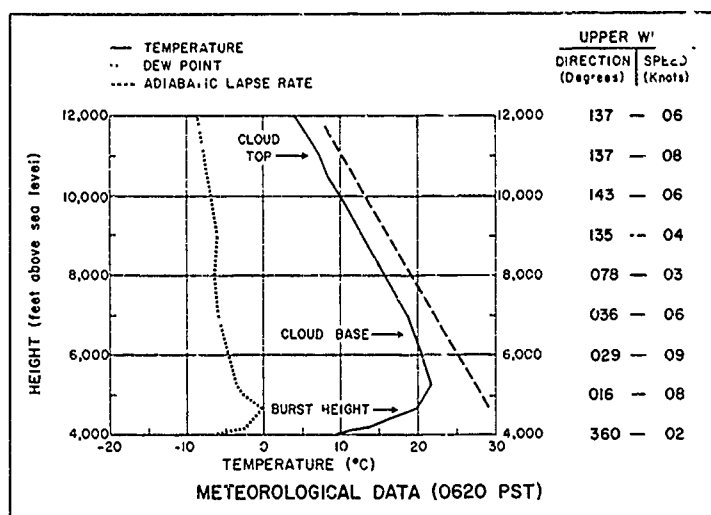
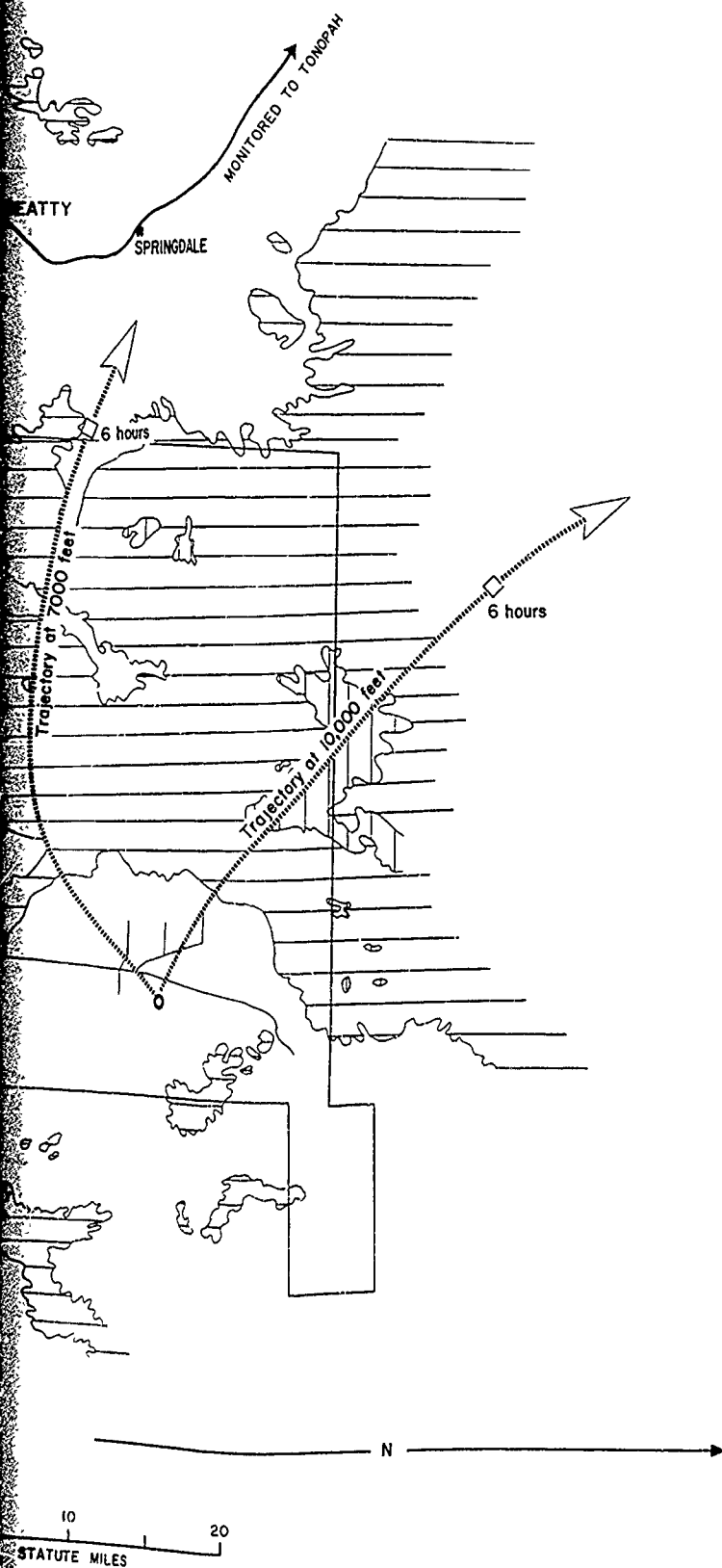
CLOUD TOP - 11,000 FT. M.S.L.

RESIDUAL GAMMA RADIATION
MR/HR AT H + 1 HOUR

- LEGEND -

———— DOSE RATE CONTOURS, MEASURED
----- DOSE RATE CONTOURS, ESTIMATED





REMARKS

Since there were no monitoring runs between the immediate ground zero area and Highway 95, it is not known whether there was any fallout between the on-site and off-site patterns as drawn.

The correlation between the trajectories shown and the fallout pattern is rather poor. The low-level winds were toward the south for approximately 6 hours after shot time; therefore, any fallout originating at 7,000 to 10,000 feet m.s.l. should have been spread out over the area south to northwest of the burst point. The air sampling of beta activity did indicate values above background at Tonopah, Goldfield, Beatty, and Lathrop Wells. Also, some gamma activity was reported by the monitors from 15 miles north of Springdale to Lathrop Wells. Thus, in addition to the fallout area shown, there was most likely some very light fallout in the general area from Lathrop Wells to Tonopah.

Although there were monitoring runs along a large number of roads off-site, the pattern as drawn is not considered to be very reliable because of the uncertainties in dealing with activity often only two or three times the background value.

DOÑA ANA (450 FT BALLOON) MAP B

H-HR= 0620 PST 16 OCT. 1958

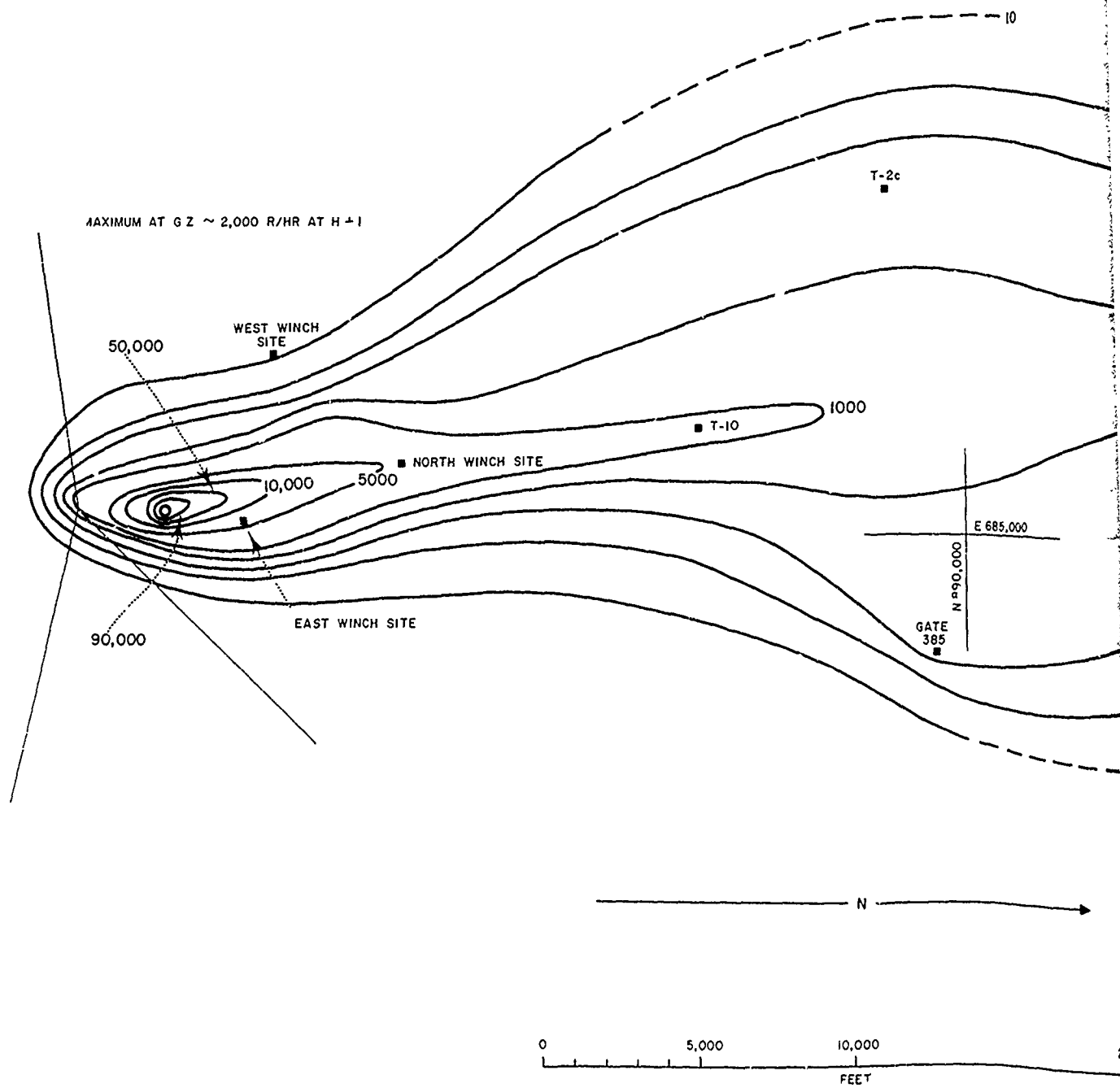
CLOUD TOP- 11,000 FT. M.S.L.

RESIDUAL GAMMA RADIATION

MR/HR AT H+1 HOUR

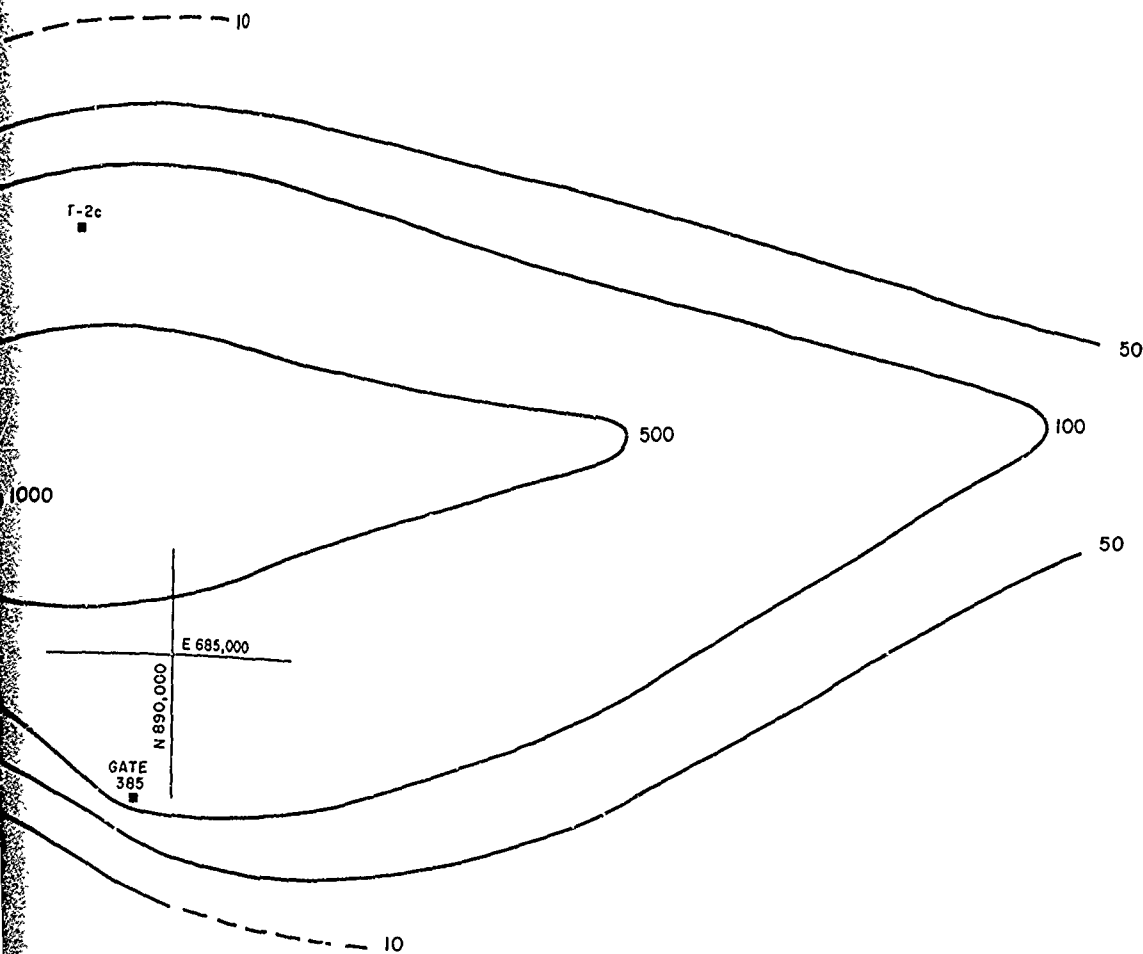
— LEGEND —

- DOSE RATE CONTOURS, MEASURED
- DOSE RATE CONTOURS, ESTIMATED
- TIME OF ARRIVAL, ESTIMATED, H+HOURS
- ===== ELEVATION 5000 TO 7000 FEET
- ===== ELEVATION 7000 TO 9000 FEET
- ===== ELEVATION MORE THAN 9000 FEET
- ROAD (THICK LINE INDICATES MONITORED SECTION)



REMARKS

The downwind extent of the 50 and 10 mr/hr isolines can only be an approximation in the absence of measurements. The rest of the on-site pattern was well documented and should be reliable.



VESTA (GRAVEL GERTIE) MAP A

H-HR = 1500 PST 17 OCT. 1958

CLOUD TOP - 10,000 FT. M.S.L.

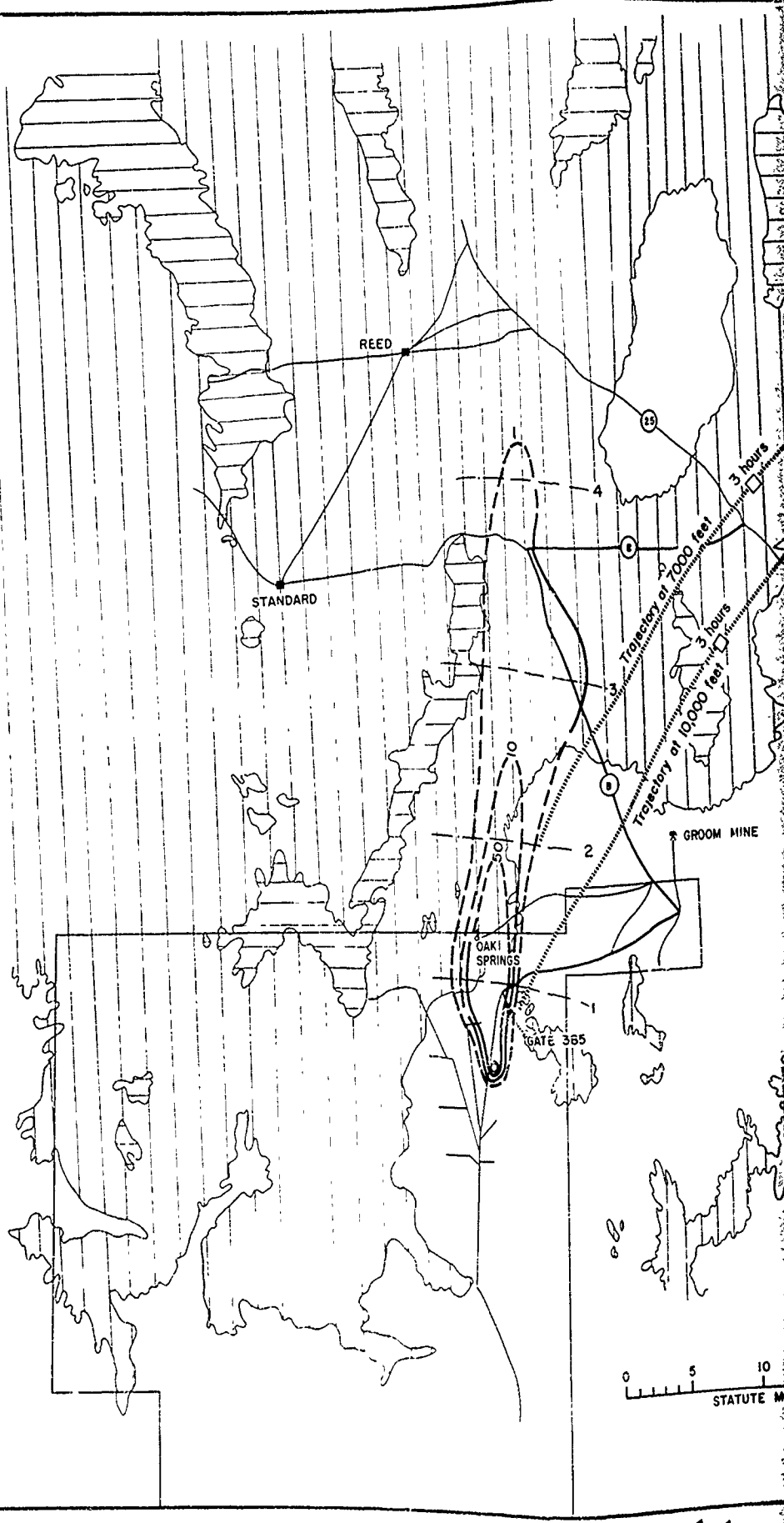
RESIDUAL GAMMA RADIATION

MR/HR AT H + 1 HOUR

- LEGEND -

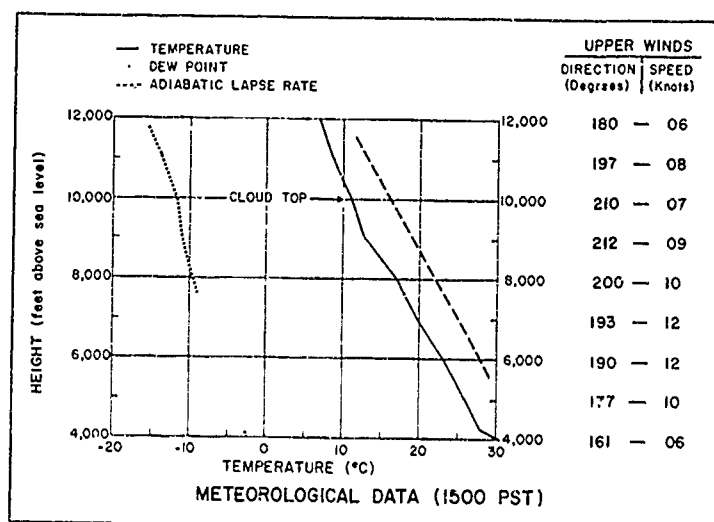
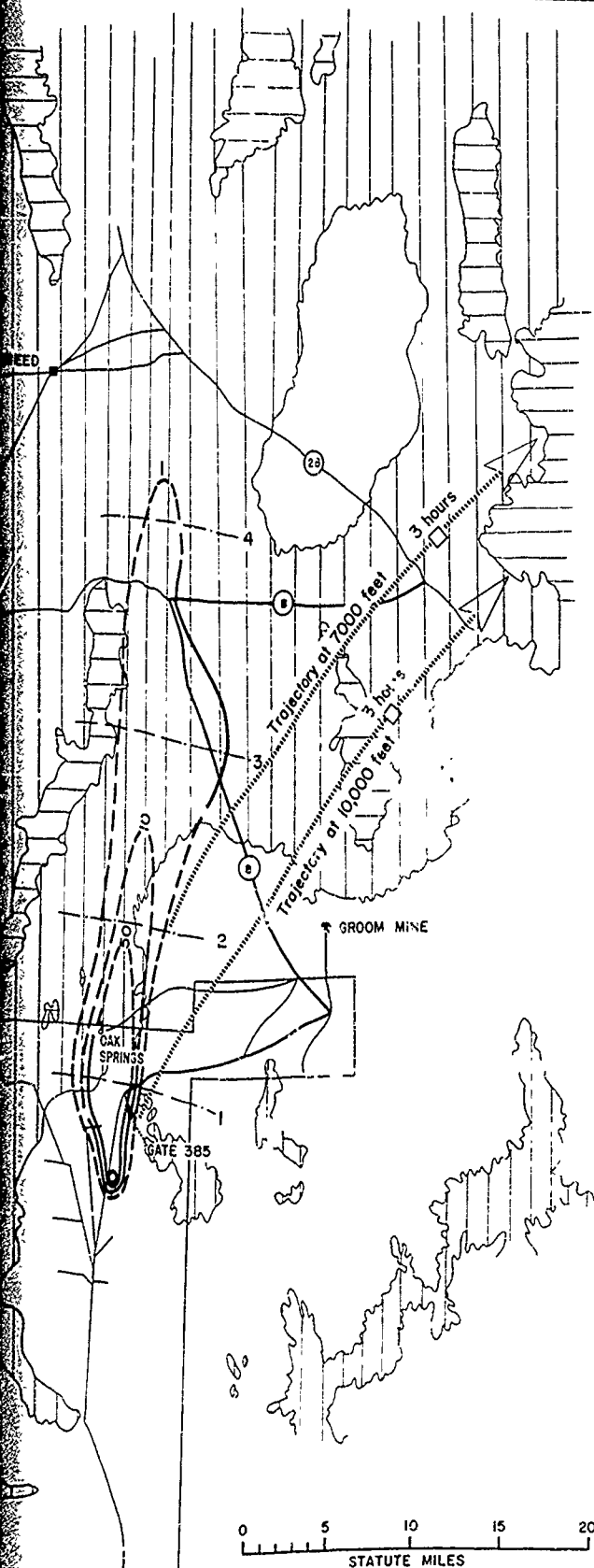
———— DOSE RATE CONTOURS, MEASURED

----- DOSE RATE CONTOURS, ESTIMATED



1.

2.



REMARKS

The cloud from Vesta was observed to rise initially to about 7,500 or 8,000 feet m.s.l. Then from the top of the cloud a large bulge rose in the manner of a cumulus cloud, reaching an altitude of about 10,000 feet at about 20 minutes after the detonation. Although the trajectories in the 7,000- to 10,000-foot layer were estimated to have passed somewhat to the east of the areas where fallout was observed, fallout from these upper parts of the cloud would have been displaced westward by the winds in the lower levels. Thus, it is not possible to say whether there was fallout from the late-rising upper part of the cloud.

The off-site portion of the fallout pattern is considered rather uncertain, since there were few radiation measurements; however, its orientation is consistent with the wind analysis.

VESTA (GRAVEL GERTIE) MAP B

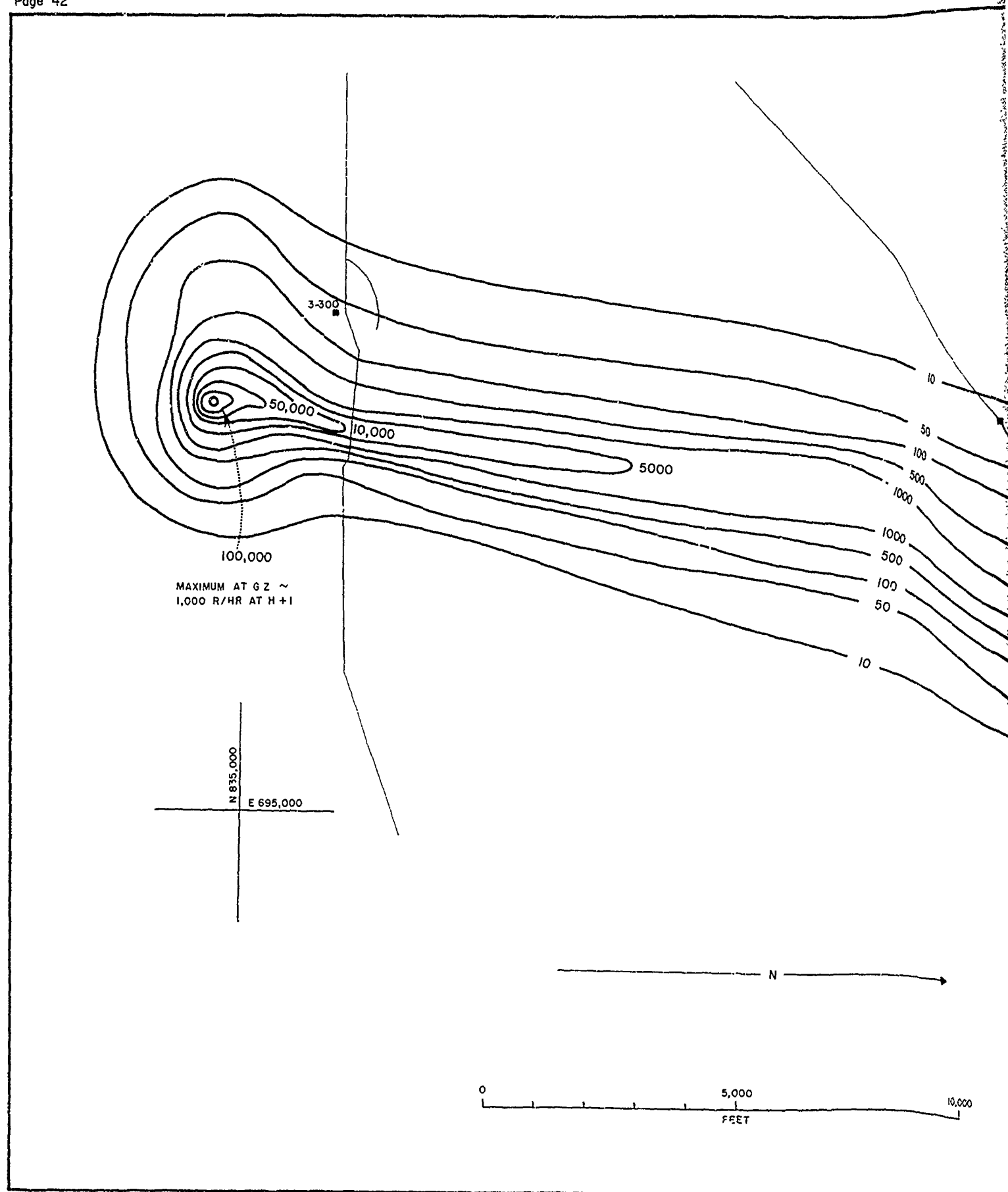
H-HR = 1500 PST 17 OCT. 1958

CLOUD TOP - 10,000 FT. M.S.L.

RESIDUAL GAMMA RADIATION
MR/HR AT H+1 HOUR

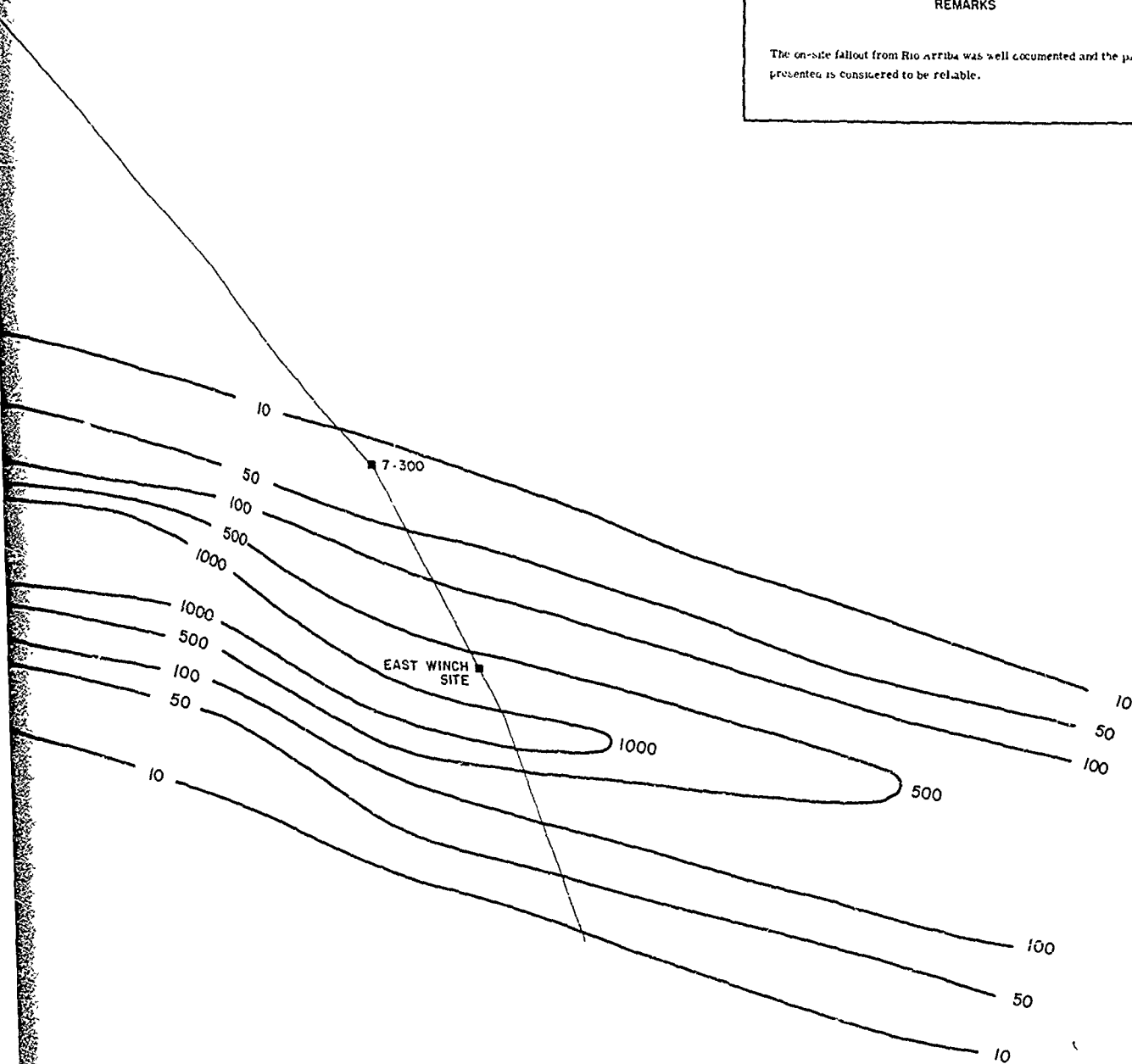
- LEGEND -

- DOSE RATE CONTOURS, MEASURED
- - - DOSE RATE CONTOURS, ESTIMATED
- - - TIME OF ARRIVAL, ESTIMATED, H+HOURS
- ELEVATION 5000 TO 7000 FEET
- ELEVATION 7000 TO 9000 FEET
- ▨ ELEVATION MORE THAN 9000 FEET
- ROAD (THICK LINE INDICATES MONITORED SECTION)



REMARKS

The on-site fallout from Rio Arriba was well documented and the pattern presented is considered to be reliable.



RIO ARRIBA (72 1/2 FT WOOD TOWER) MAP A

H-HR = 0625 PST 18 OCT ,958

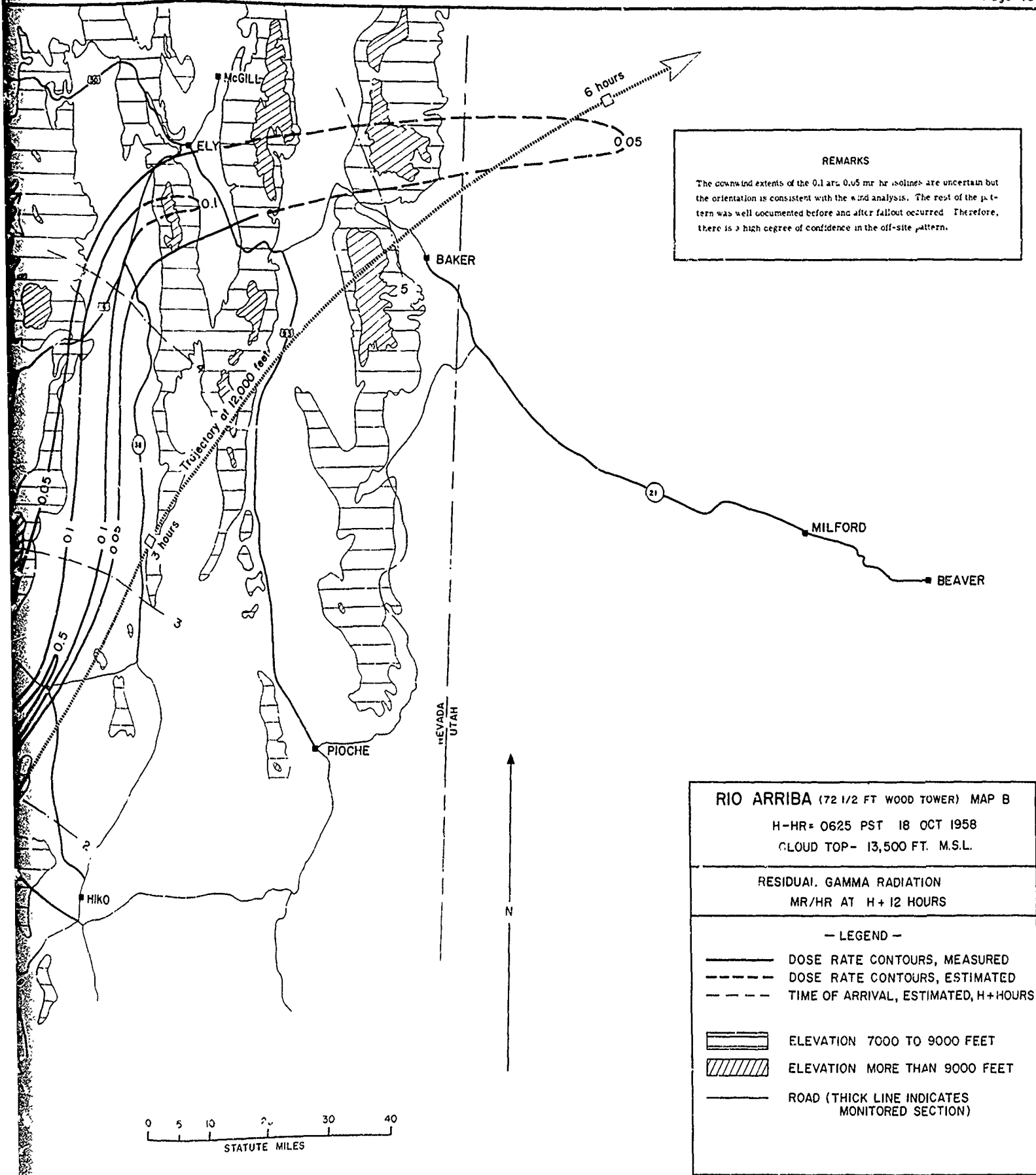
CLOUD TOP - 13,500 FT M.S.L.

RESIDUAL GAMMA RADIATION

MR/HR AT H + 1 HOUR

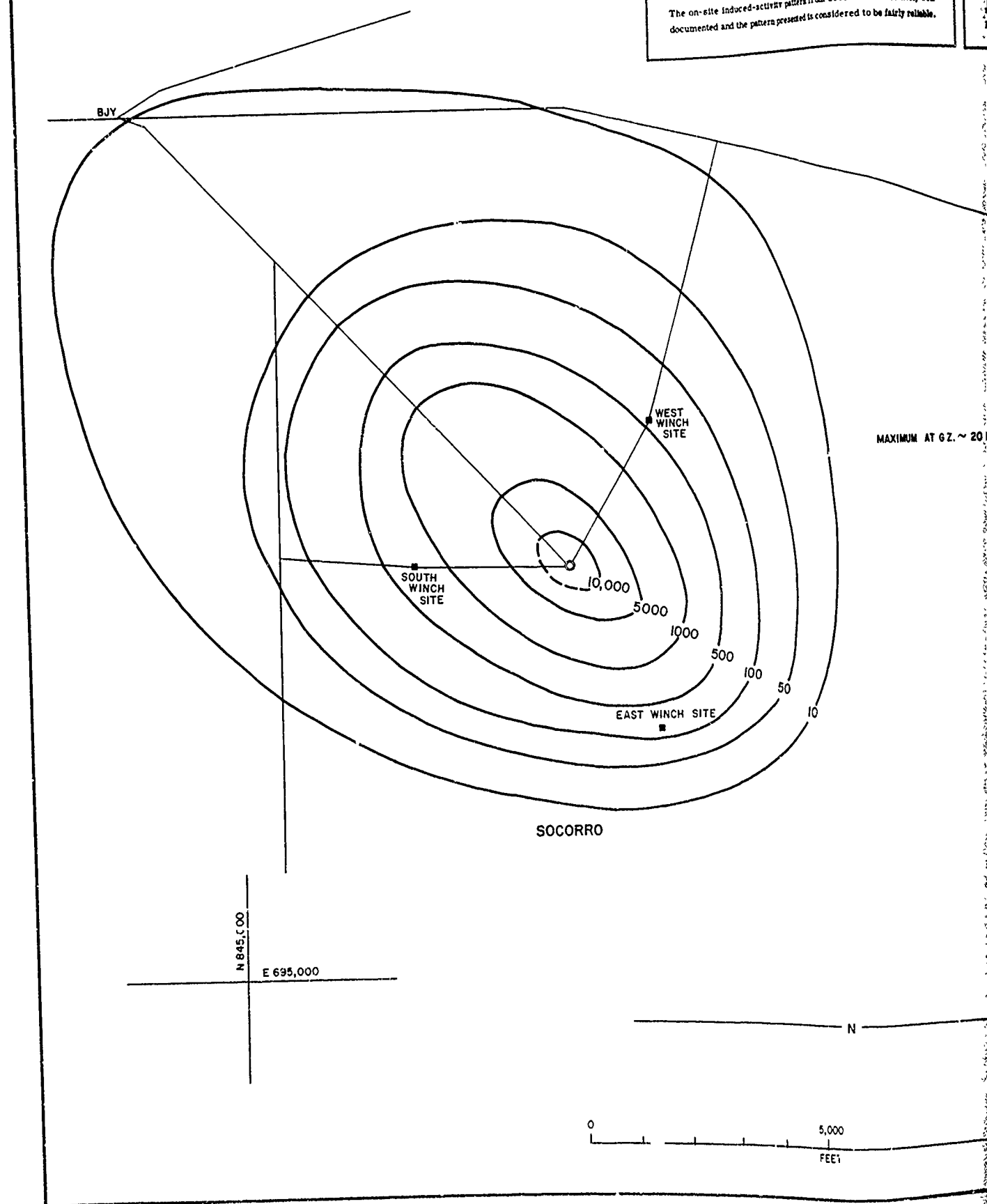
- LEGEND -

- DOSE RATE CONTOURS, MEASURED
- DOSE RATE CONTOURS, ESTIMATED



Socorro
REMARKS

The on-site induced-activity pattern from Socorro was relatively well documented and the pattern presented is considered to be fairly reliable.

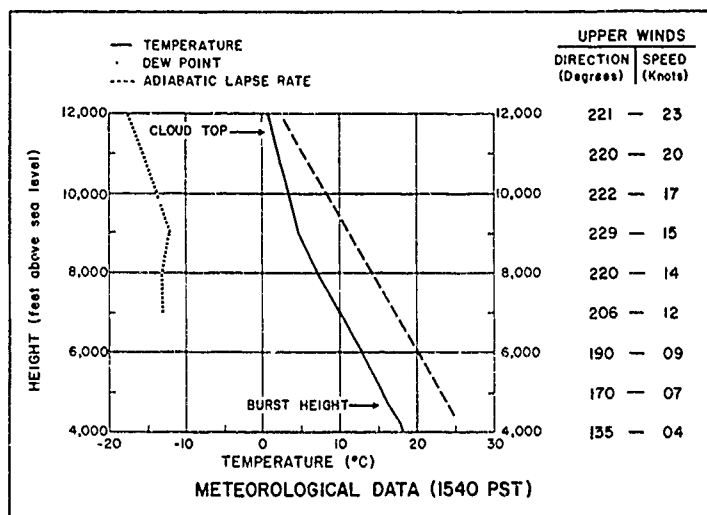
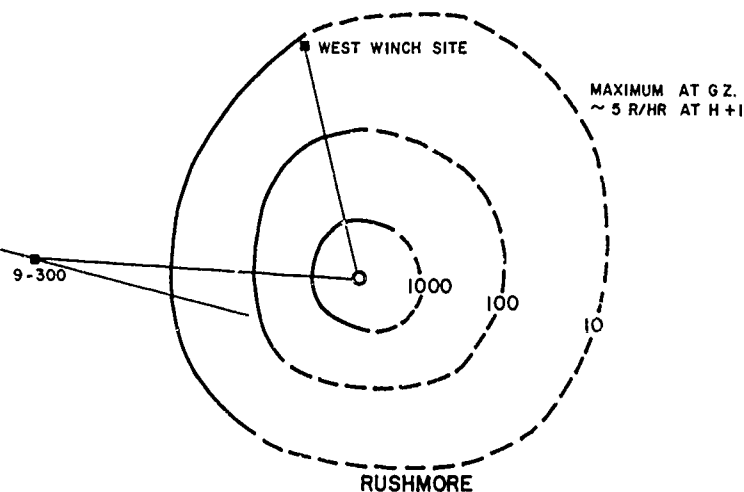
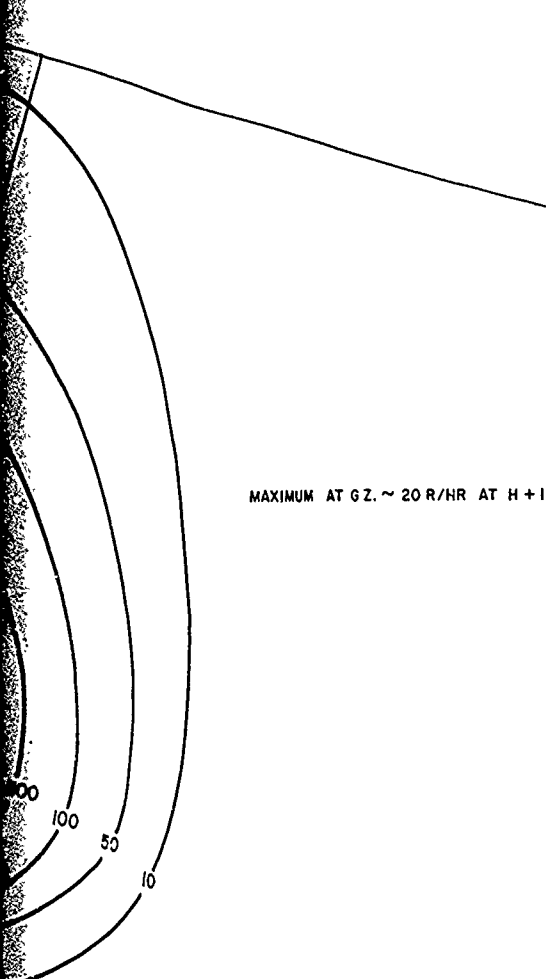


Socorro
REMARKS

On-site induced-activity pattern from Socorro was relatively well
estimated and the pattern presented is considered to be fairly reliable.

Rushmore
REMARKS

Because of the lack of data in some areas around ground zero there is
not a high degree of confidence in the analysis of the on-site pattern for
Rushmore.



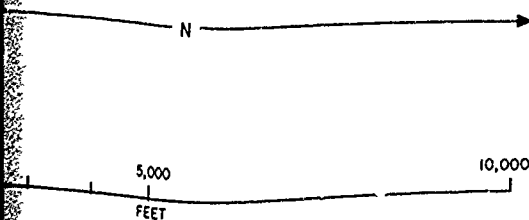
RUSHMORE (500 FT. BALLOON) MAP A
H-HR= 1540 PST 22 OCT. 1958
CLOUD TOP- 11,500 FT. M.S.L.

SOCORRO (1450 FT. BALLOON) MAP A
H-HR= 0530 PST 22 OCT. 1958
CLOUD TOP- 26,000 FT. M.S.L.

RESIDUAL GAMMA RADIATION
MR/HR AT H+1 HOUR

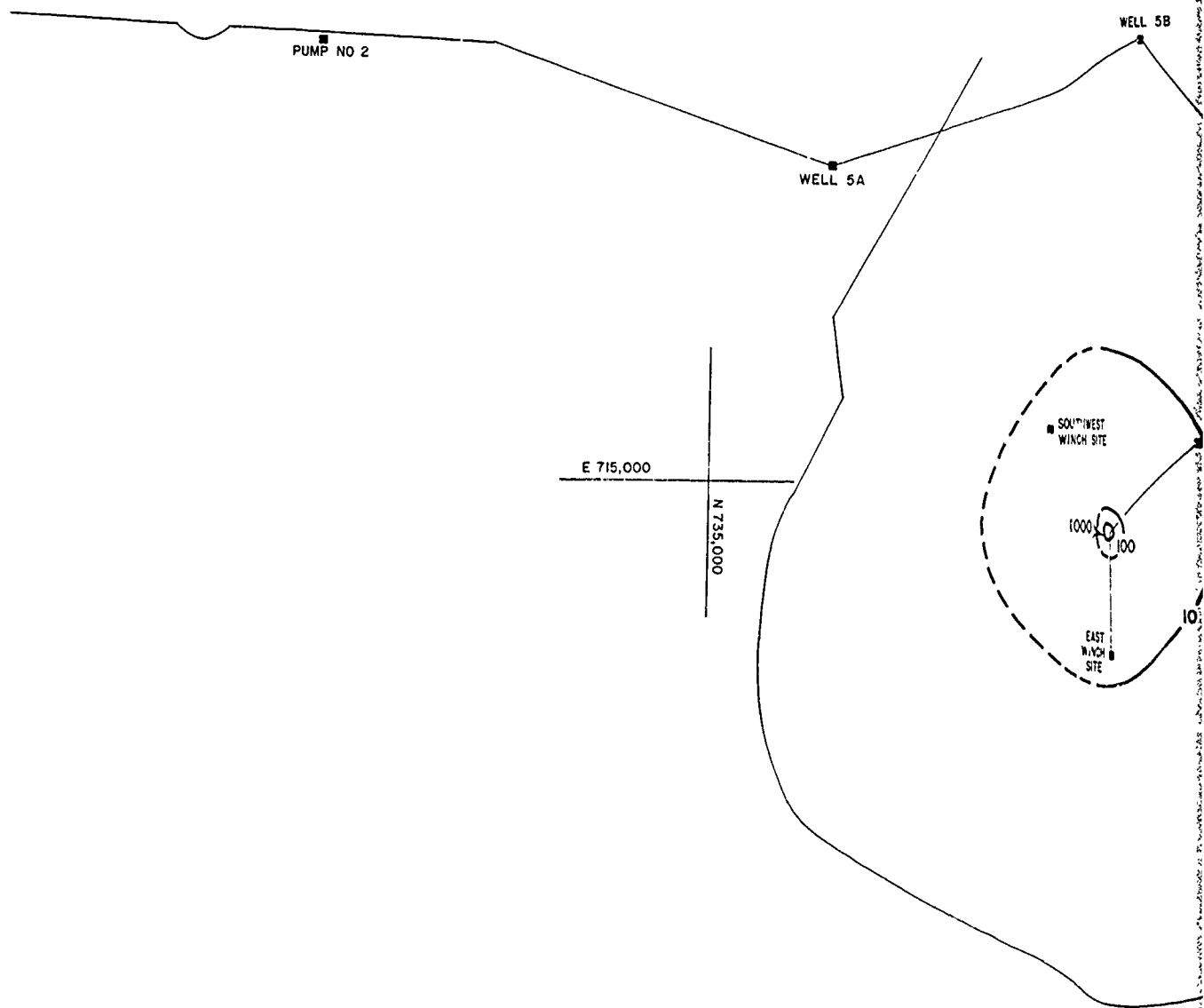
— LEGEND —

———— DOSE RATE CONTOURS, MEASURED
----- DOSE RATE CONTOURS, ESTIMATED



7

REMARKS
 Because of lack of data in some areas
 not a 100% degree of confidence in the map

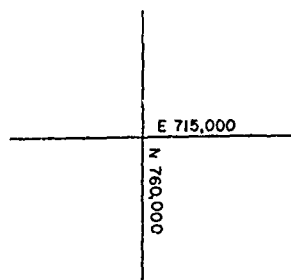
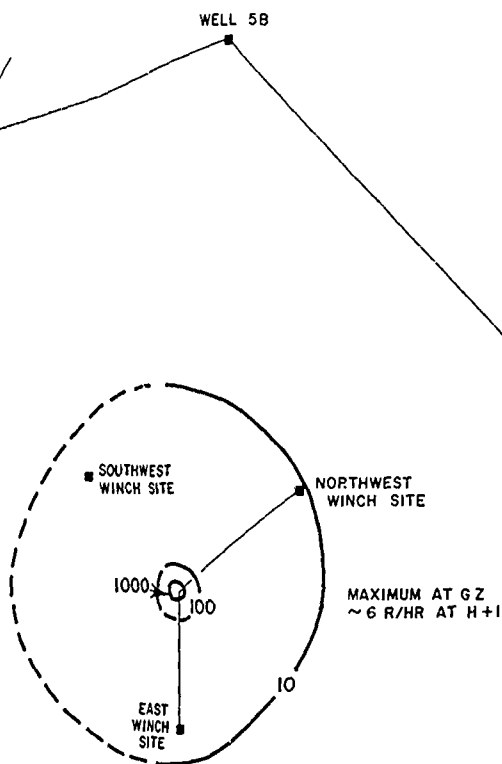
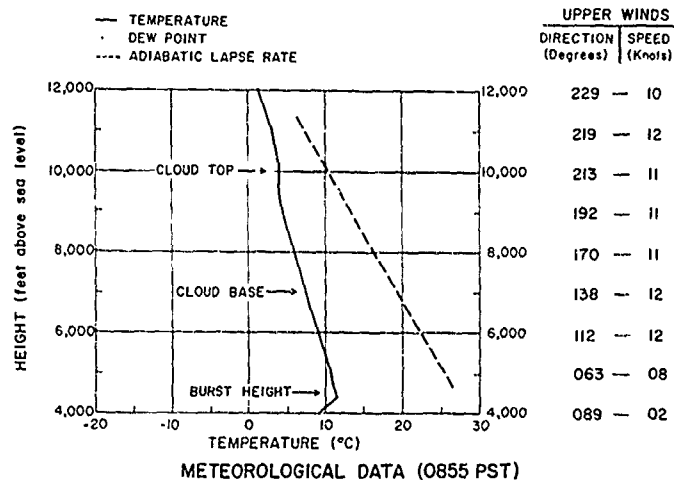


N

0 5,000
 FEET

REMARKS

Because of the lack of data in some areas around ground zero there is not a high degree of confidence in the analysis of the on-site pattern.



WRANGELL (1500 FT BALLOON) MAP A

H-HR = 0850 PST 22 OCT 1958

CLOUD TOP - 10,000 FT M.S.L.

RESIDUAL GAMMA RADIATION

MR/HR AT H+1 HOUR

— LEGEND —

- DOSE RATE CONTOURS, MEASURED
- DOSE RATE CONTOURS, ESTIMATED



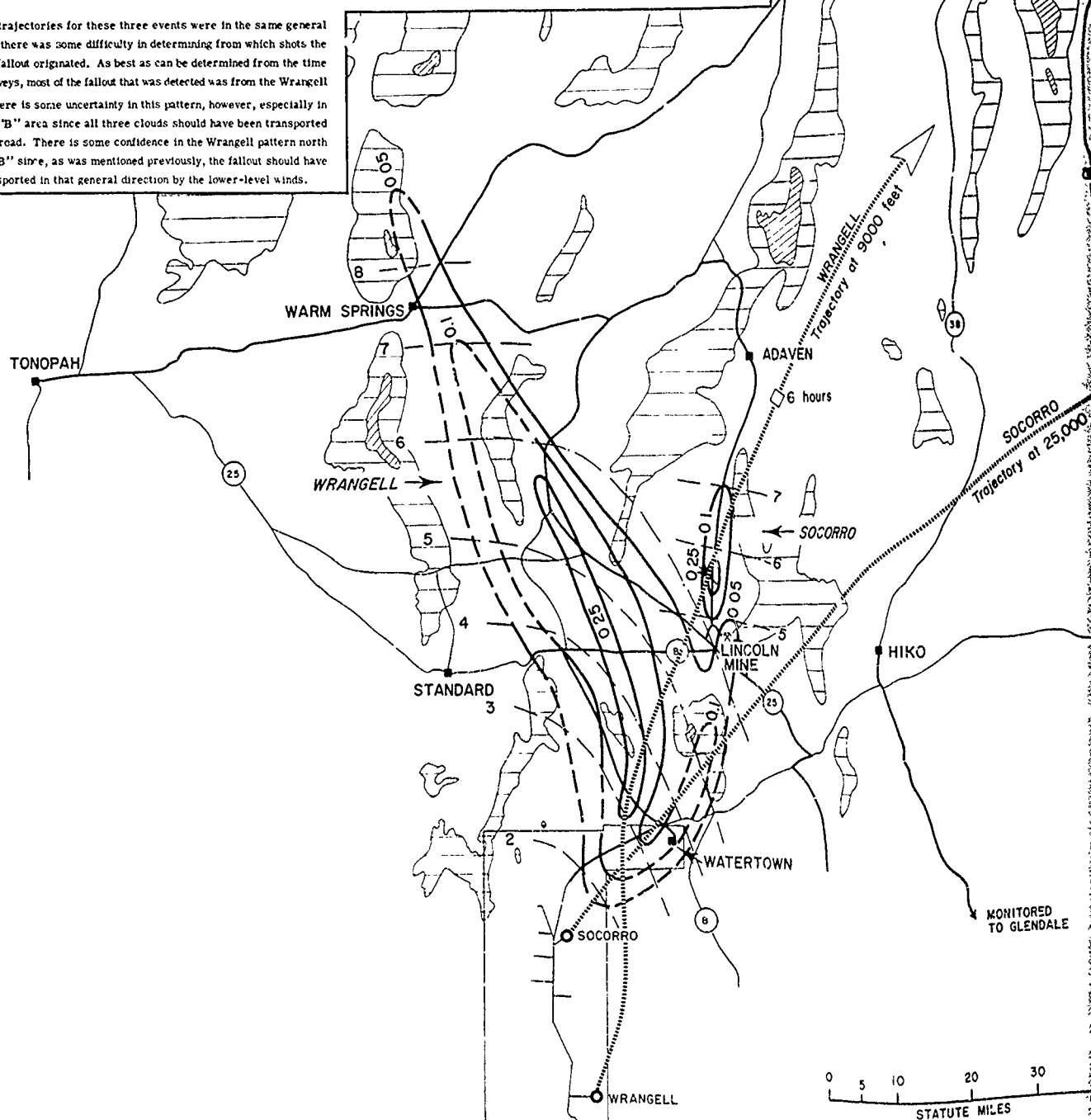
Socorro was the first of three nuclear detonations to occur on the same day. The trajectory analysis for these three events indicated that the clouds should all have been transported in the same general direction.

Although the Wrangell trajectory was toward the north and northeast, the lower level winds would have transported any fallout originating at 9,000 feet m.s.l. toward the north and northwest.

Since the trajectories for these three events were in the same general direction, there was some difficulty in determining from which shots the observed fallout originated. As best as can be determined from the time of the surveys, most of the fallout that was detected was from the Wrangell event. There is some uncertainty in this pattern, however, especially in the Road "B" area since all three clouds should have been transported over this road. There is some confidence in the Wrangell pattern north of Road "B" since, as was mentioned previously, the fallout should have been transported in that general direction by the lower-level winds.

A high reading of 30 mr/hr was recorded at Lincoln Mine at H-2.2 hours and attributed to Rushmore since that was about the time that the Rushmore cloud should have been over this area. Later readings at Lincoln Mine indicated activities only several times above background which may have been fallout from Rushmore or possibly from Wranzell or Socorro.

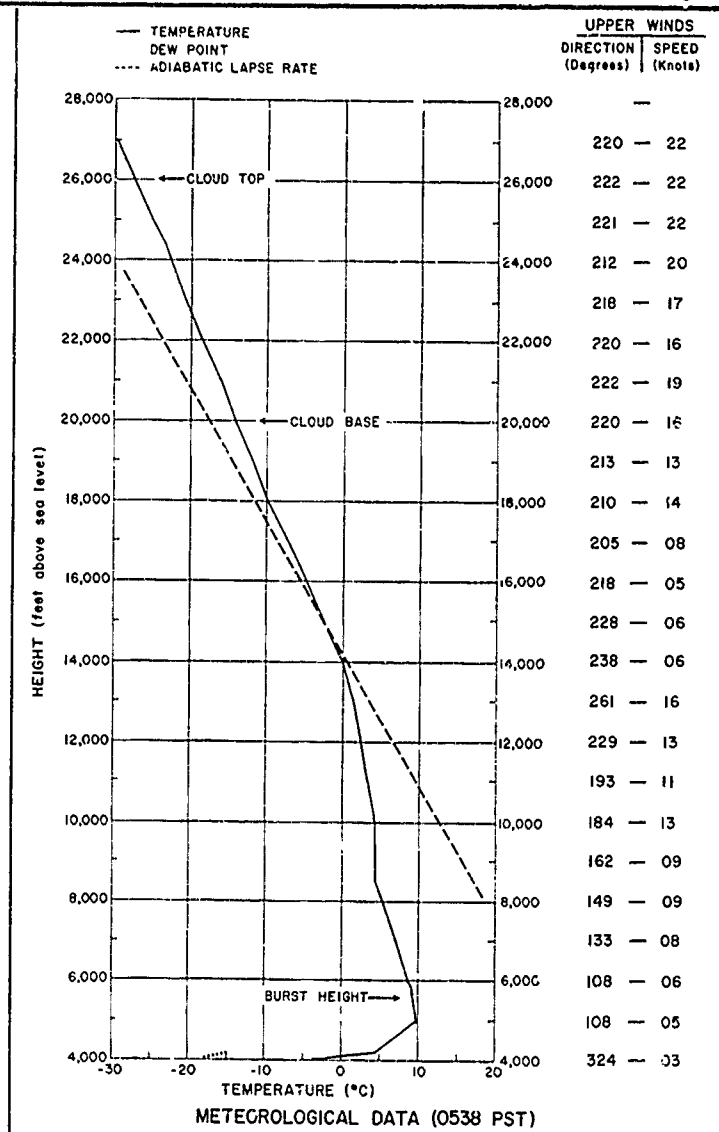
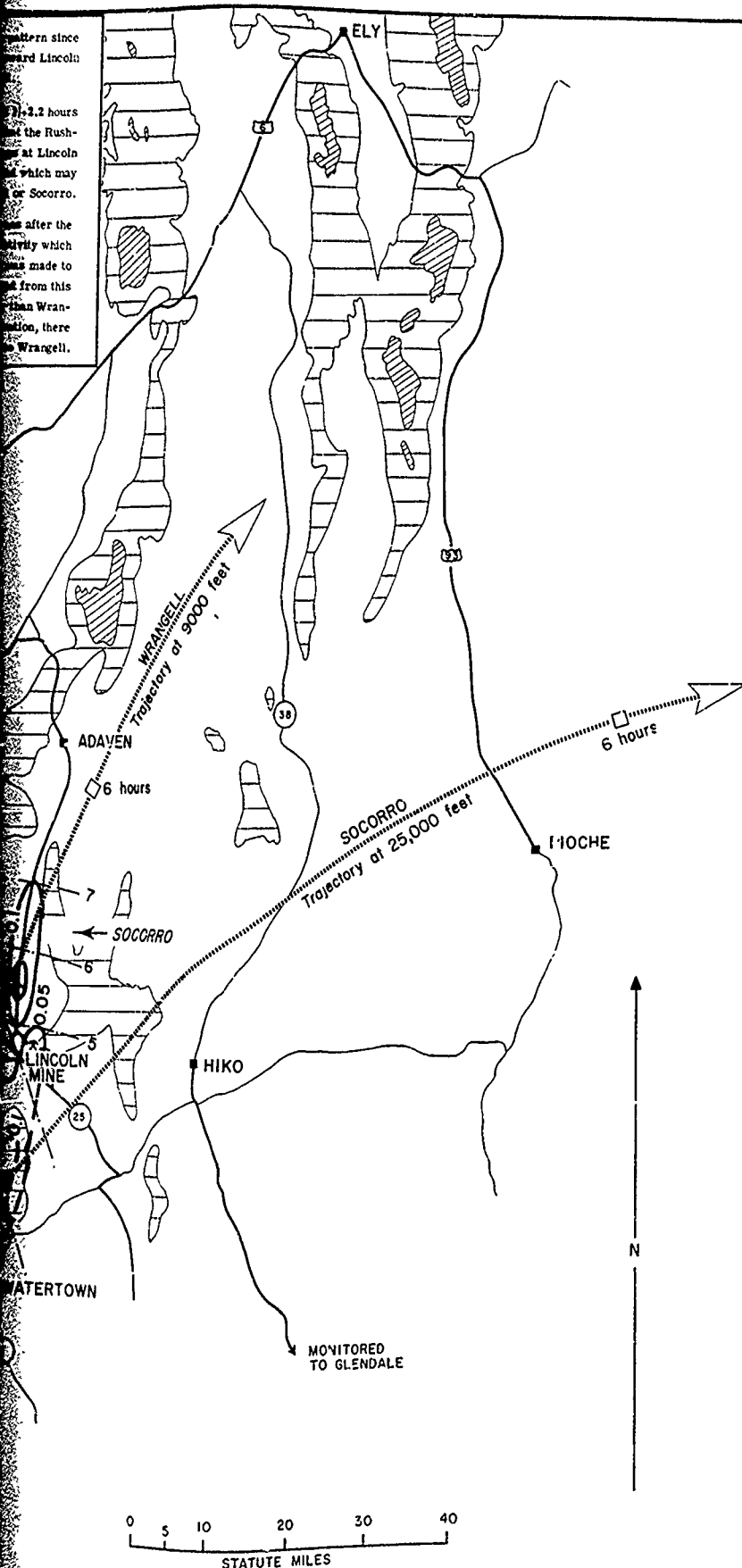
Since it was late in the day, there were very few monitor runs after the Rushmore event. The survey the next day indicated light activity which may have been from any of the three events. No attempt was made to draw a pattern for Rushmore, but there may have been fallout from this detonation. In fact, since Rushmore had a yield slightly greater than W-angel and their respective clouds rose to about the same elevation, there may have been as much or more fallout as has been attributed to W-angel.



pattern since
ward Lincoln

2.2 hours
at the Rush-
at Lincoln
which may
Socorro.

after the
activity which
made to
from this
Wran-
tion, there
Wrangell.



SOCORRO (1450 FT BALLOON) MAP B
H-HR= 0530 PST 22 OCT 1958
CLOUD TOP- 26,000 FT M.S.L.

WRANGELL (1500 FT BALLOON) MAP B
H-HR= 0850 PST 22 OCT. 1958
CLOUD TOP- 10,000 FT. M.S.L.

RESIDUAL GAMMA RADIATION
MR/HR AT H+12 HOURS

— LEGEND —

- DOSE RATE CONTOURS, MEASURED
- DOSE RATE CONTOURS, ESTIMATED
- TIME OF ARRIVAL, ESTIMATED, H+HOURS
- ELEVATION 7000 TO 9000 FEET
- ELEVATION MORE THAN 9000 FEET
- ROAD (THICK LINE INDICATES MONITORED SECTION)

REMARKS

The on-site fallout from Catron was well documented and the pattern presented is considered to be reliable. A special on-site survey was very helpful in delineating the Catron fallout from the Juno fallout, especially in the area west of the Mercury Highway.

5

10

50

N

E 670,000

N 825,000

10

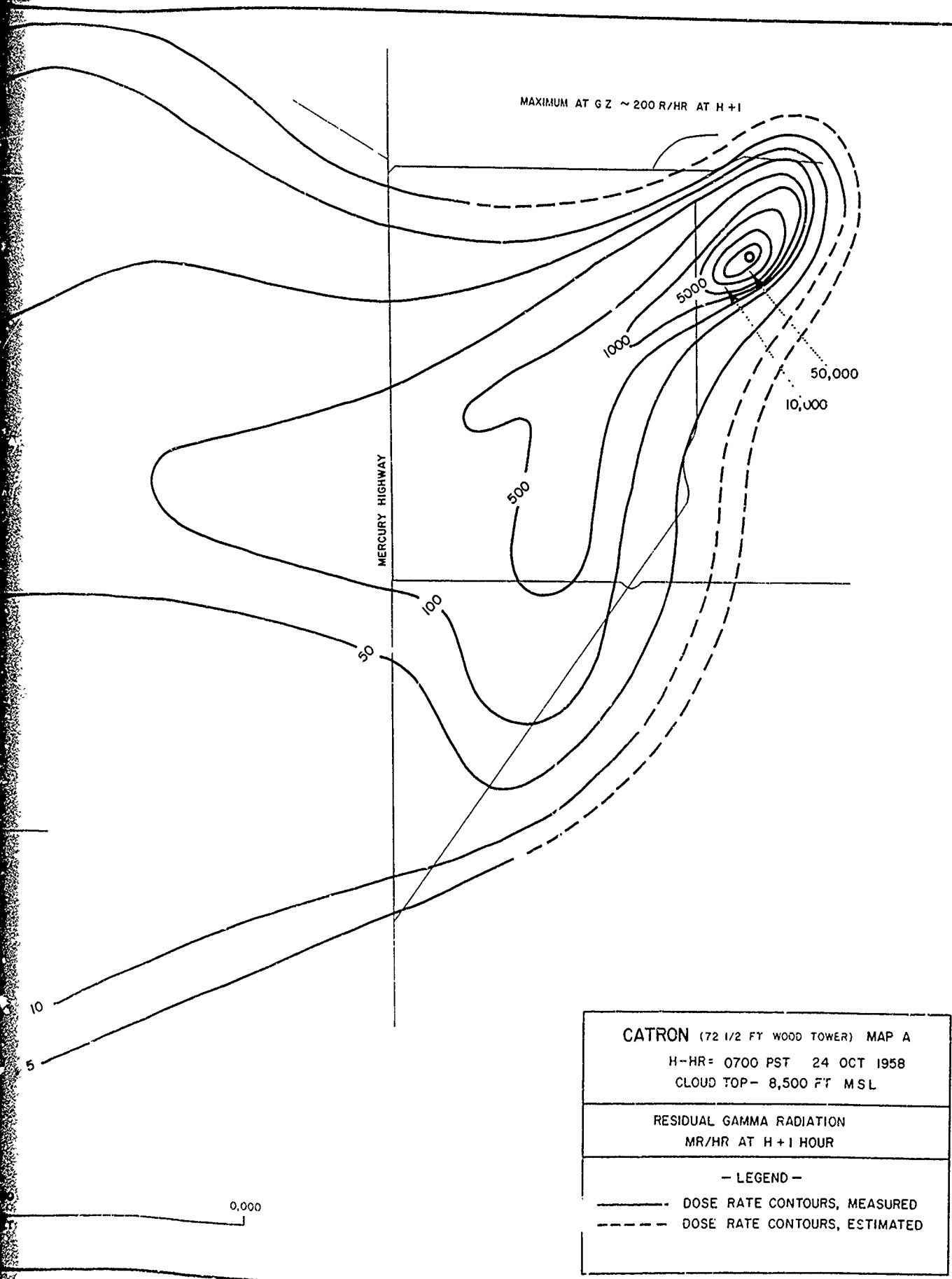
5

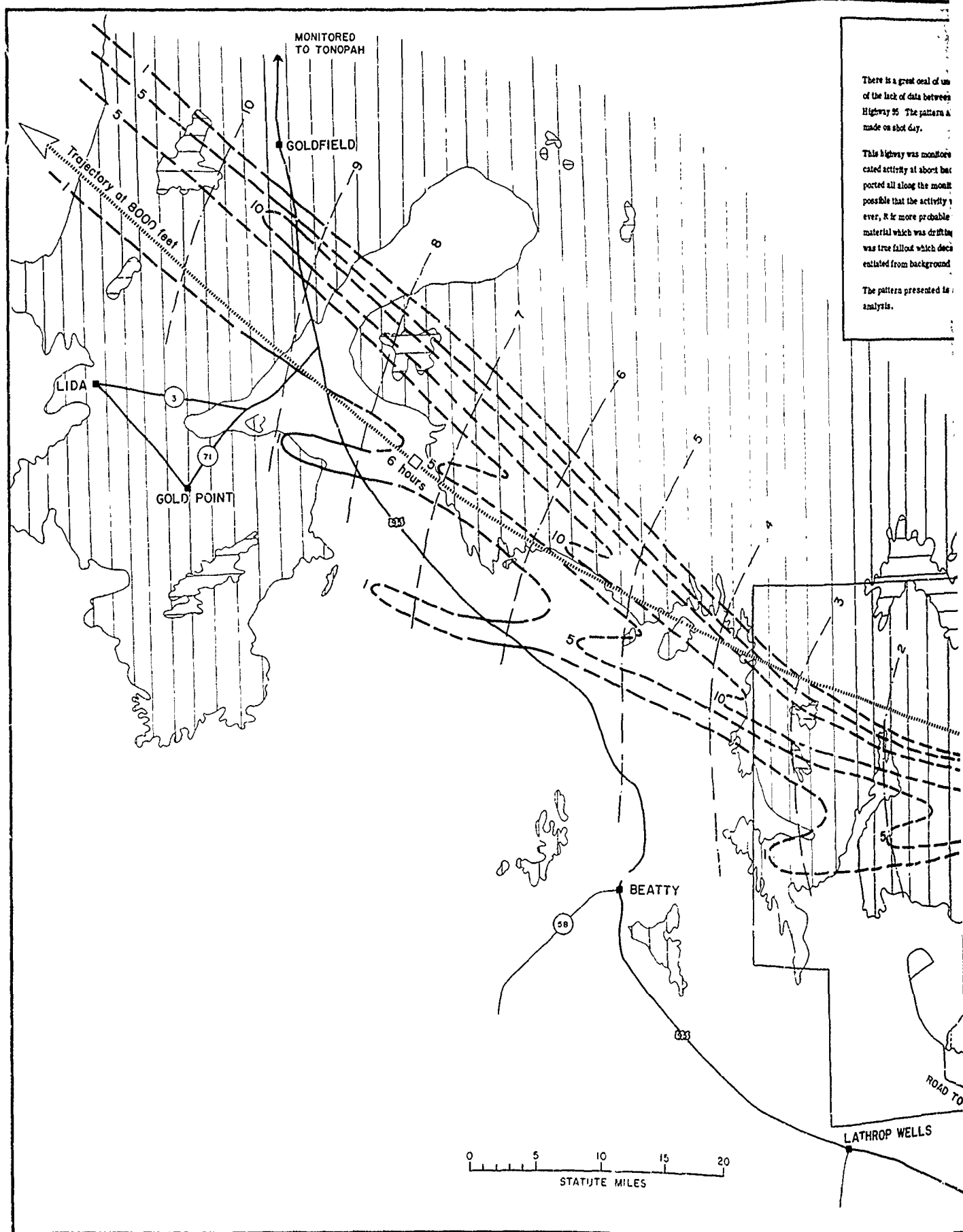
0

5,000

10,000

FEET



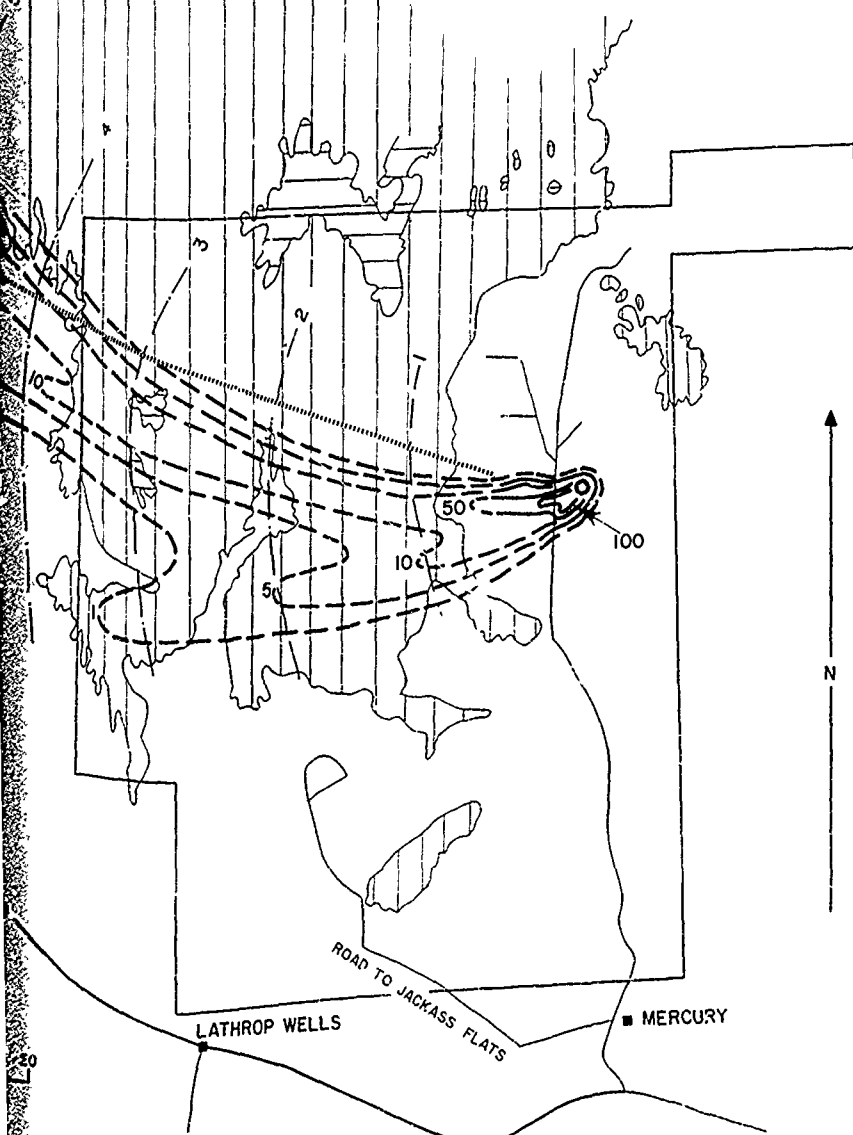
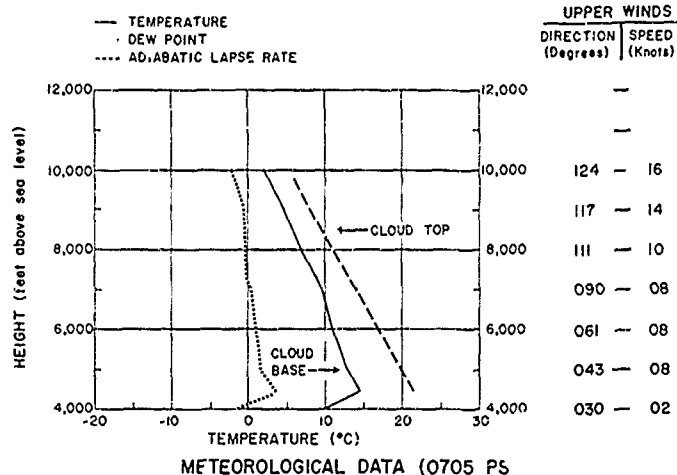


REMARKS

There is a great deal of uncertainty in the Catron pattern off-site because of the lack of data between the immediate area around the burst site and Highway 95. The pattern along Highway 95 is based on the measurements made on shot day.

This highway was monitored again the following day, and all reports indicated activity at about background levels. Scattered showers were reported all along the monitored part of this highway on shot day, so it is possible that the activity was washed into the ground by the rain. However, it is more probable that the activity reported was due to airborne material which was drifting by while it was being monitored or that there was true fallout which decayed by the next day to levels not easily differentiated from background radiation.

The pattern presented is at least qualitatively consistent with the wind analysis.



CATRON (72 1/2 FT WOOD TOWER) MAP B

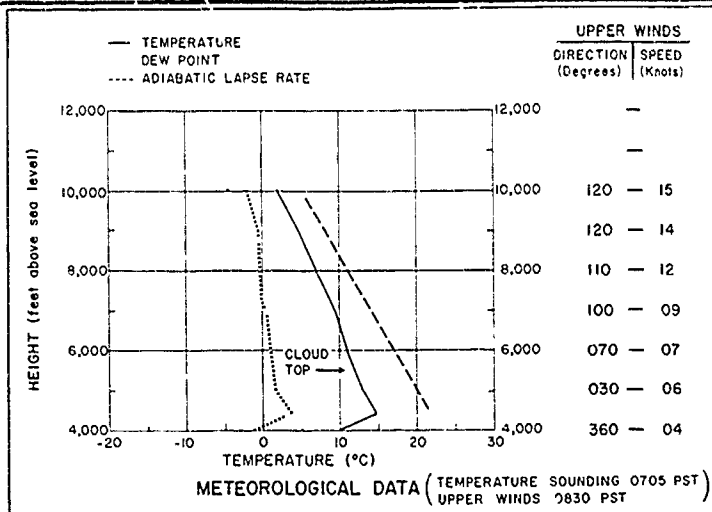
H-HR= 0700 PST 24 OCT. 1958

CLOUD TOP- 8,500 FT. M.S.L.

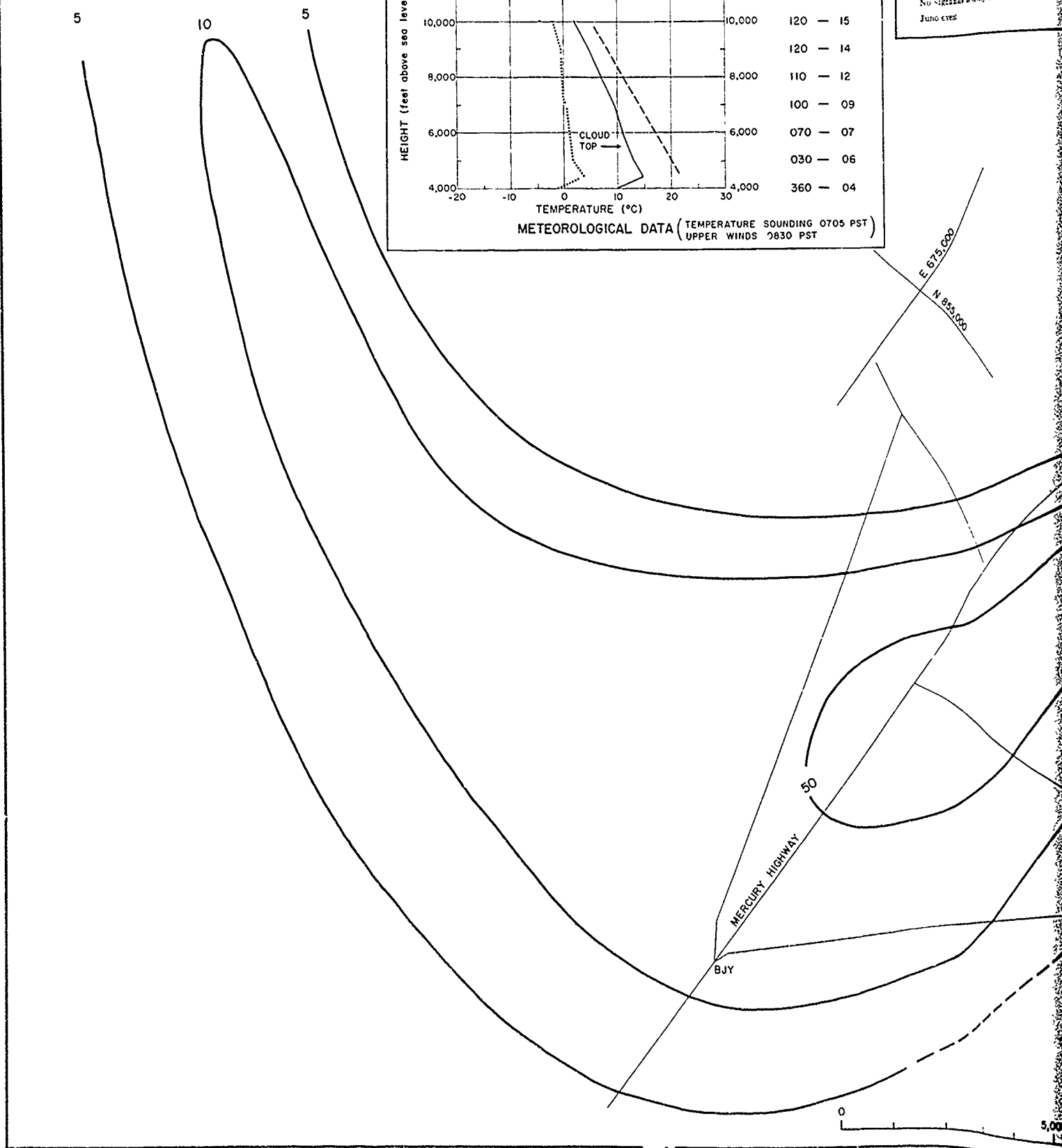
RESIDUAL GAMMA RADIATION
MR/HR AT H+1 HOUR

- LEGEND -

- DOSE RATE CONTOURS, MEASURED
- - - DOSE RATE CONTOURS, ESTIMATED
- - - TIME OF ARRIVAL, ESTIMATED, H+HOURS
- ELEVATION 5000 TO 7000 FEET
- ELEVATION 7000 TO 9000 FEET
- ELEVATION MORE THAN 9000 FEET
- ROAD (THICK LINE INDICATES MONITORED SECTION)



REMARKS
 A fire on site that from June was well de
 sented here a considered to be reliable
 No significant activity of site was reported
 June even



UPPER WINDS

DIRECTION (Degrees) | SPEED (Knots)

12,000	—
10,000	120 — 15
8,000	120 — 14
6,000	110 — 12
4,000	100 — 09
3,000	070 — 07
2,000	030 — 06
1,000	360 — 04

REMARKS

The on-site wind from Juno was well documented and the pattern presented here is considered to be reliable.

No significant activity of size was reported that could be attributed to the Juno event.

TEMPERATURE SOUNDING 0705 PST
UPPER WINDS 0830 PST

E 675,000
N 855,000

MERCURY HIGHWAY

SOUTHEAST WINCH SITE

MAXIMUM AT GZ ~1000R/HR AT H+1

JUNO (GRAVEL GERTIE) MAP A

H-HR = 0801 PST 24 OCT 1958

CLOUD TOP = 5,500 FT MSL

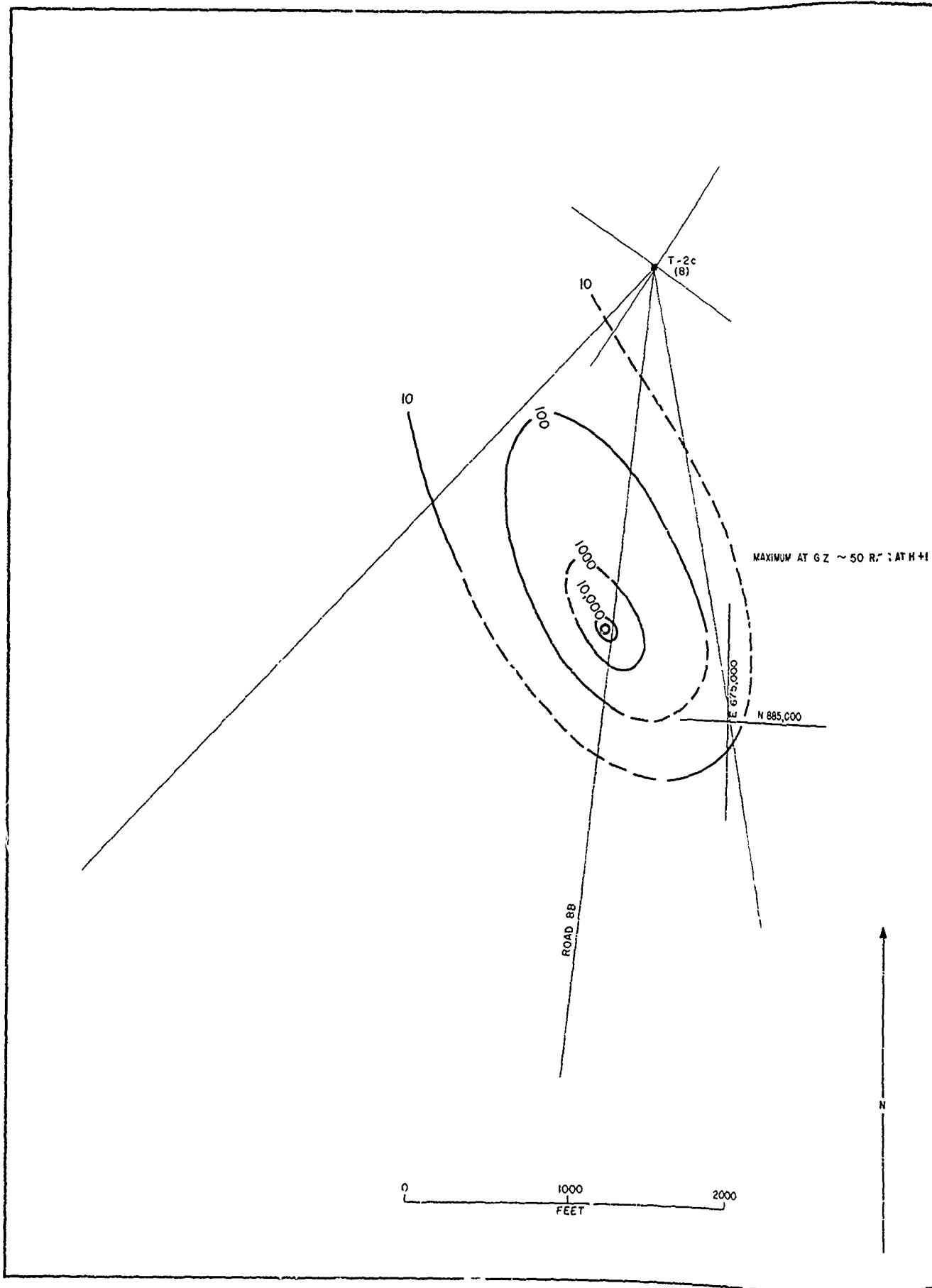
RESIDUAL GAMMA RADIATION

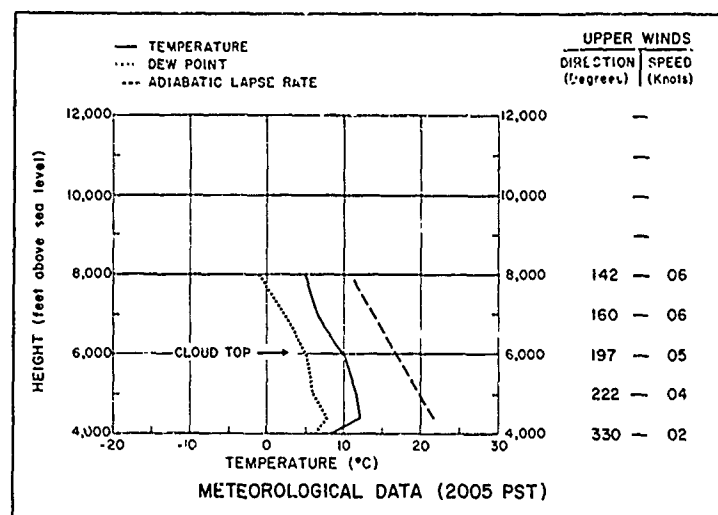
MR 'HR AT H+1 HOUR

— LEGEND —

— DOSE RATE CONTOURS, MEASURED
- - - DOSE RATE CONTOURS, ESTIMATED

0 5,000 10,000
FEET





REMARKS

There was a trivial yield from Ceres, and a cloud height of about 6,000 feet m.s.l. (a rise of about 1,500 feet) was observed. Because of the lateness of the day, the proximity of the mountainous terrain and the low cloud height, the lowest portion of the nuclear cloud was under the influence of drainage winds. The shot-time surface wind observations at Station 353 (located about 2-1/2 miles south of the burst point on Road 8B) and at the Yucca Lake station (located about 15 miles south of the burst point) indicated that the drainage winds had set in by shot time and were approximately from the northwest.

According to the Yucca Lake winds from above the drainage level to the top of the cloud the debris should have been deposited toward the northeast of the burst point. The radiation data strongly suggests that the debris was deposited toward the northwest. A possible explanation of the discrepancy between the observed radiation field and the wind field is that, since the winds were rather light, the observed winds at the Yucca Lake weather station were probably not representative of the air flow over Area 6 at these low levels.

No activity above background was detected off site.

15-Minute Average Winds

20-foot Tower at Station 353
 (Surface Elevation About 4325 feet m.s.l.)

Time (PST)	Direction (degrees)	Speed (m.p.h.)
1745-1800	160	05
1845-1900	275	03
1945-2000	320	03
2045-2100	310	06

CERES (25 FT. WOOD TOWER) MAP A
 H-HR = 2000 PST 25 OCT 1958
 CLOUD TOP - 6000 FT MSL

RESIDUAL GAMMA RADIATION
 MR/HR AT H+1 HOUR

- LEGEND -

— DOSE RATE CONTOURS, MEASURED
 --- DOSE RATE CONTOURS, ESTIMATED

T-2c
(8)

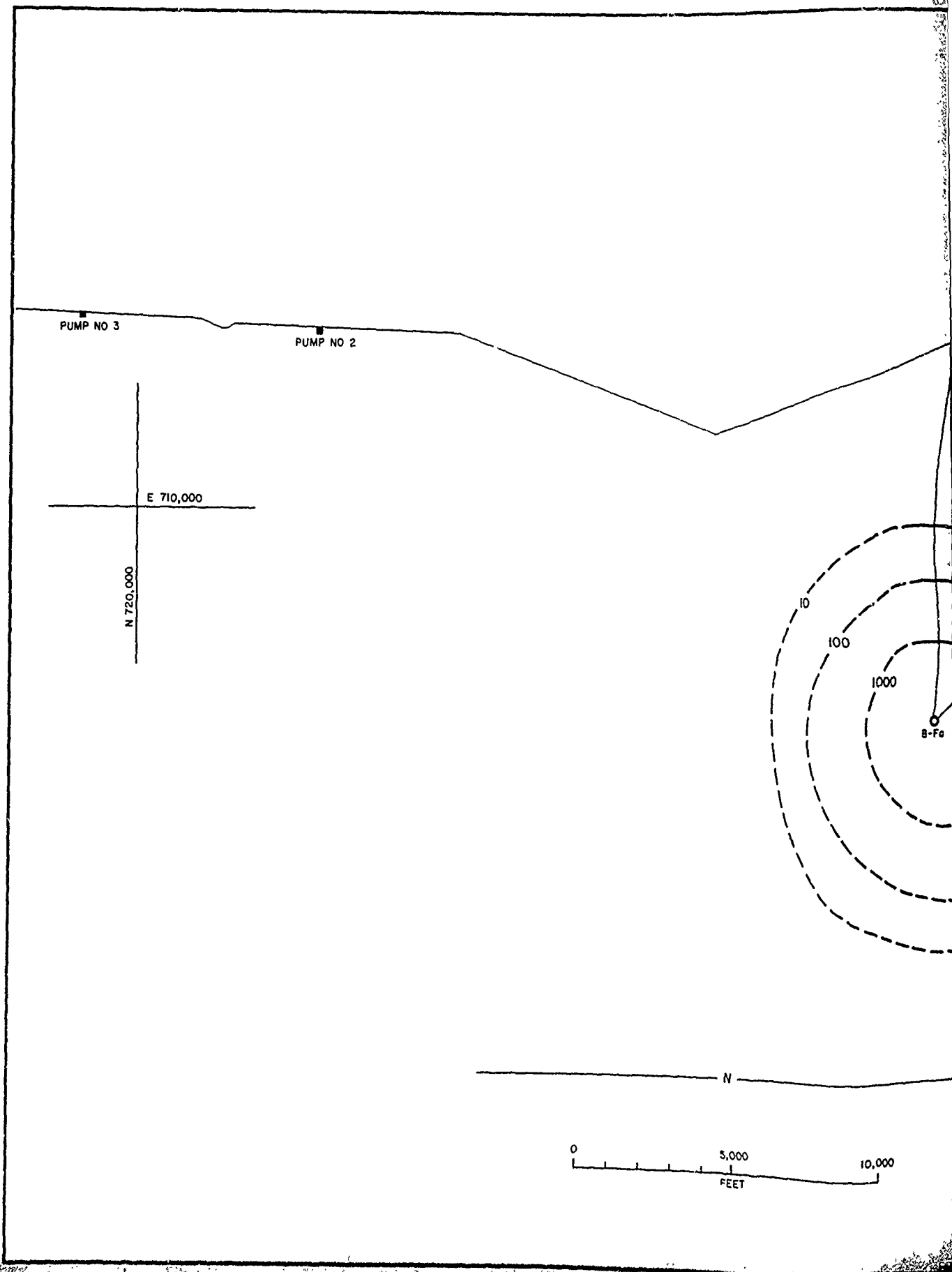
MAXIMUM AT 62 ~ 50 R/HR AT H+1

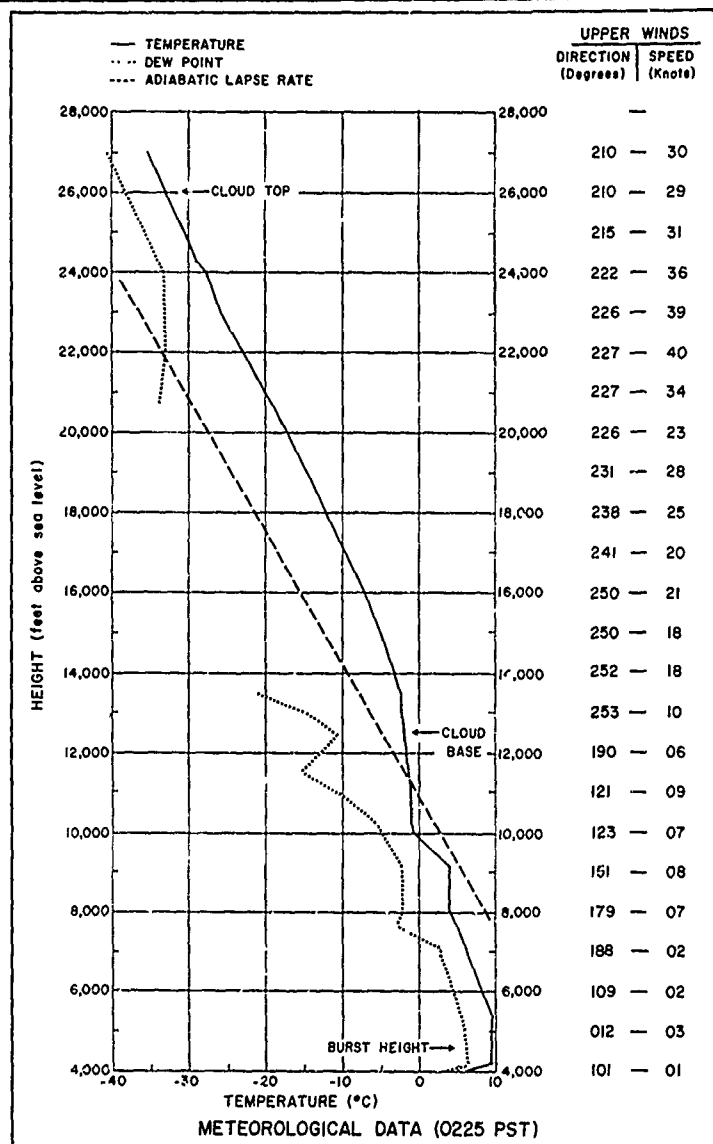
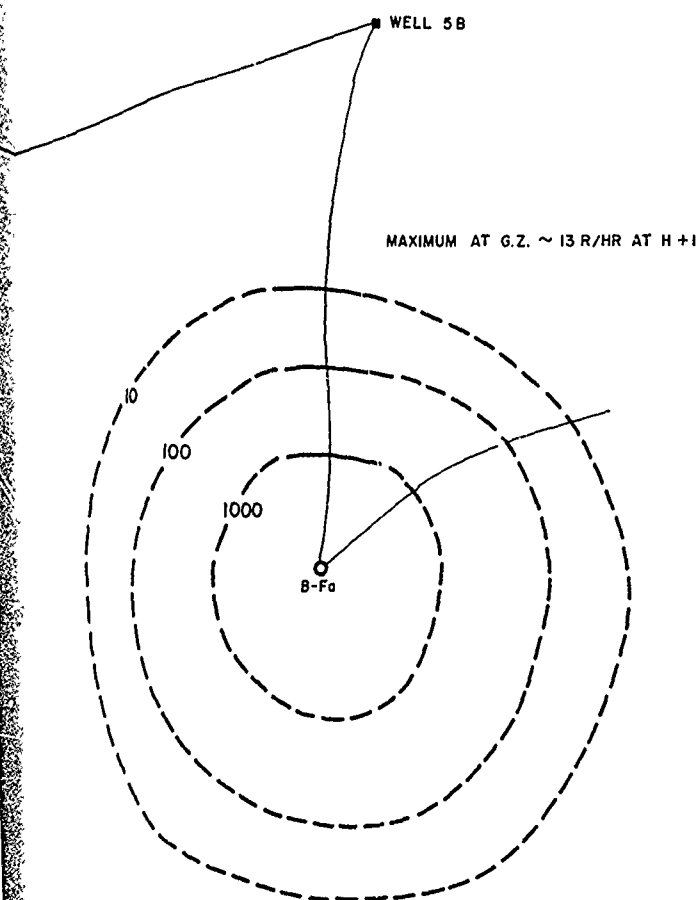
E 675,000

N 885,000

2000

N





REMARKS

Because of the lack of data in most of the areas around ground zero, there is not a very high degree of confidence in the analysis of the on-site pattern.

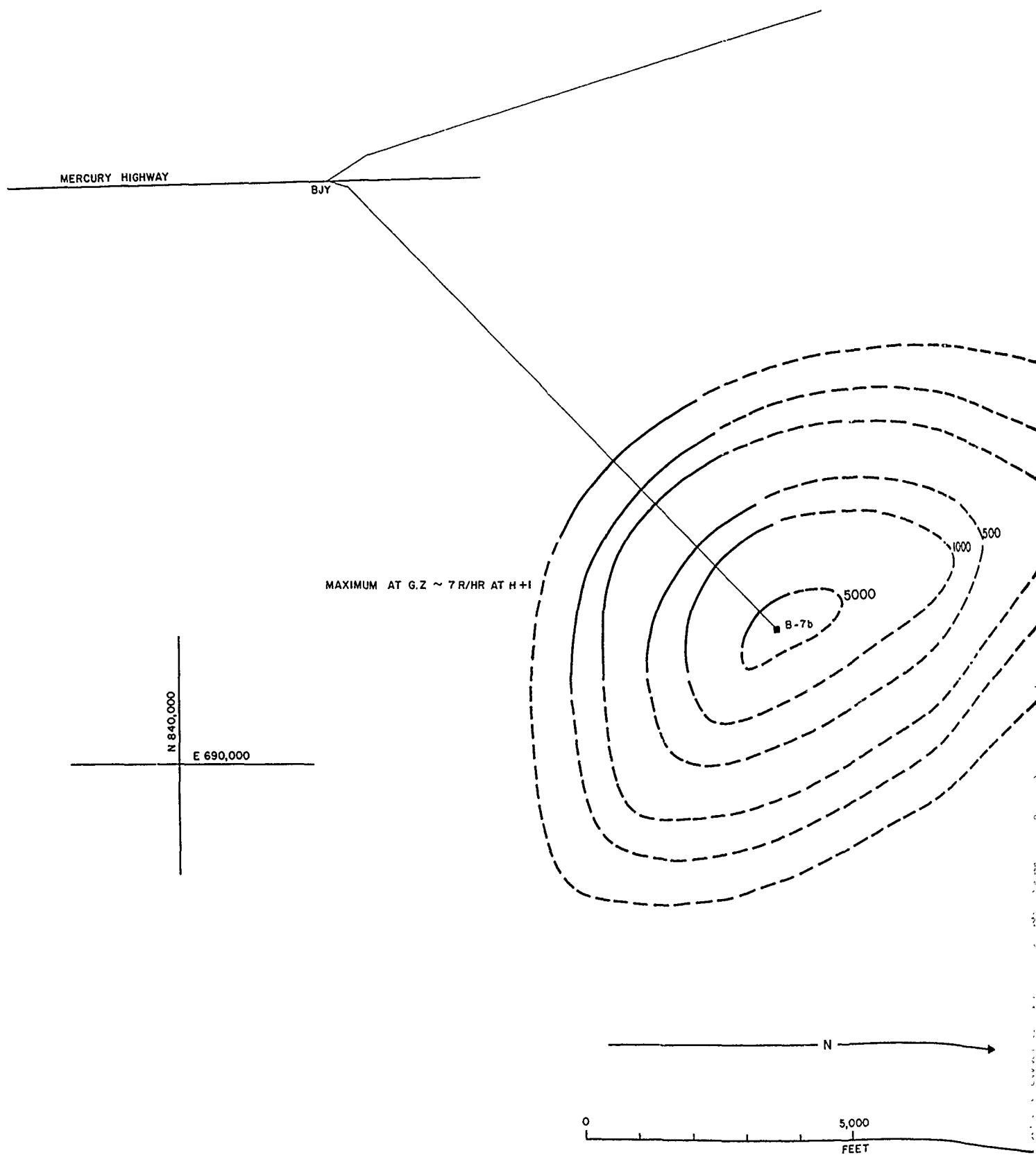
SANFORD (1500 FT BALLOON) MAP A
H-HR = 0220 PST 26 OCT. 1958
CLOUD TOP - 26,000 FT. M.S.L.

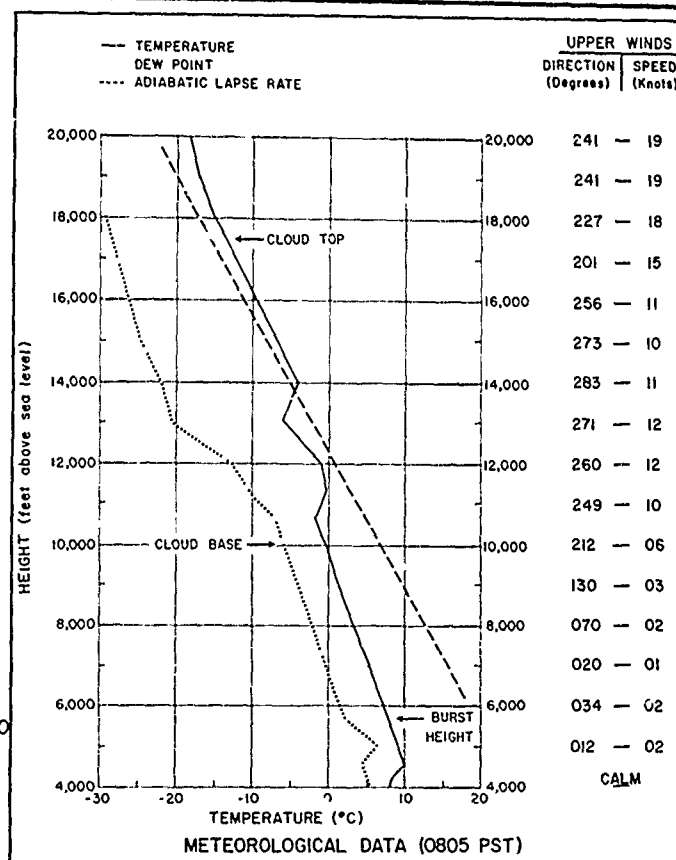
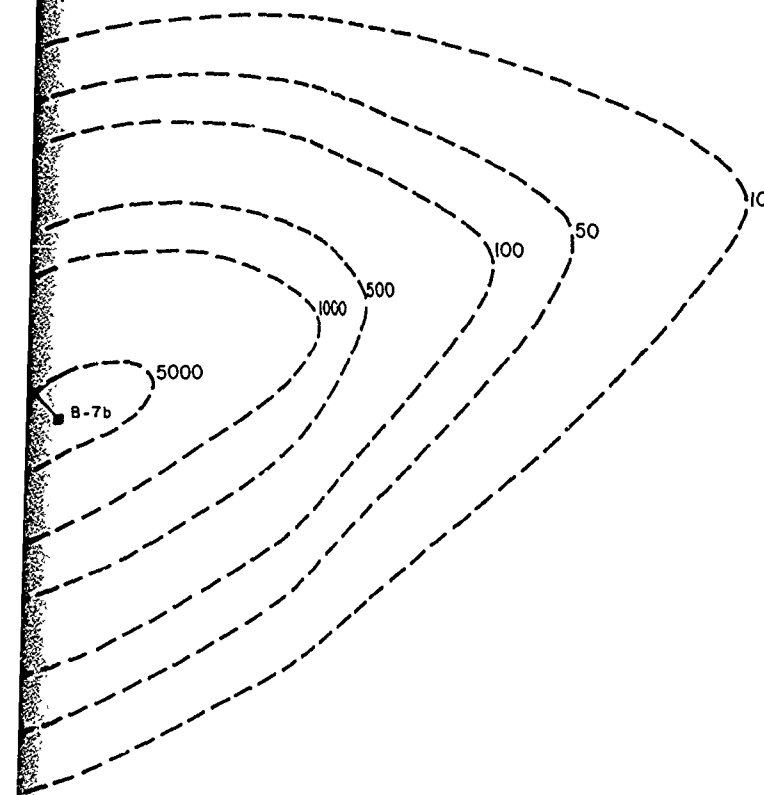
RESIDUAL GAMMA RADIATION
MR/HR AT H+1 HOUR

— LEGEND —

———— DOSE RATE CONTOURS, MEASURED
----- DOSE RATE CONTOURS, ESTIMATED

10,000
FEET





REMARKS

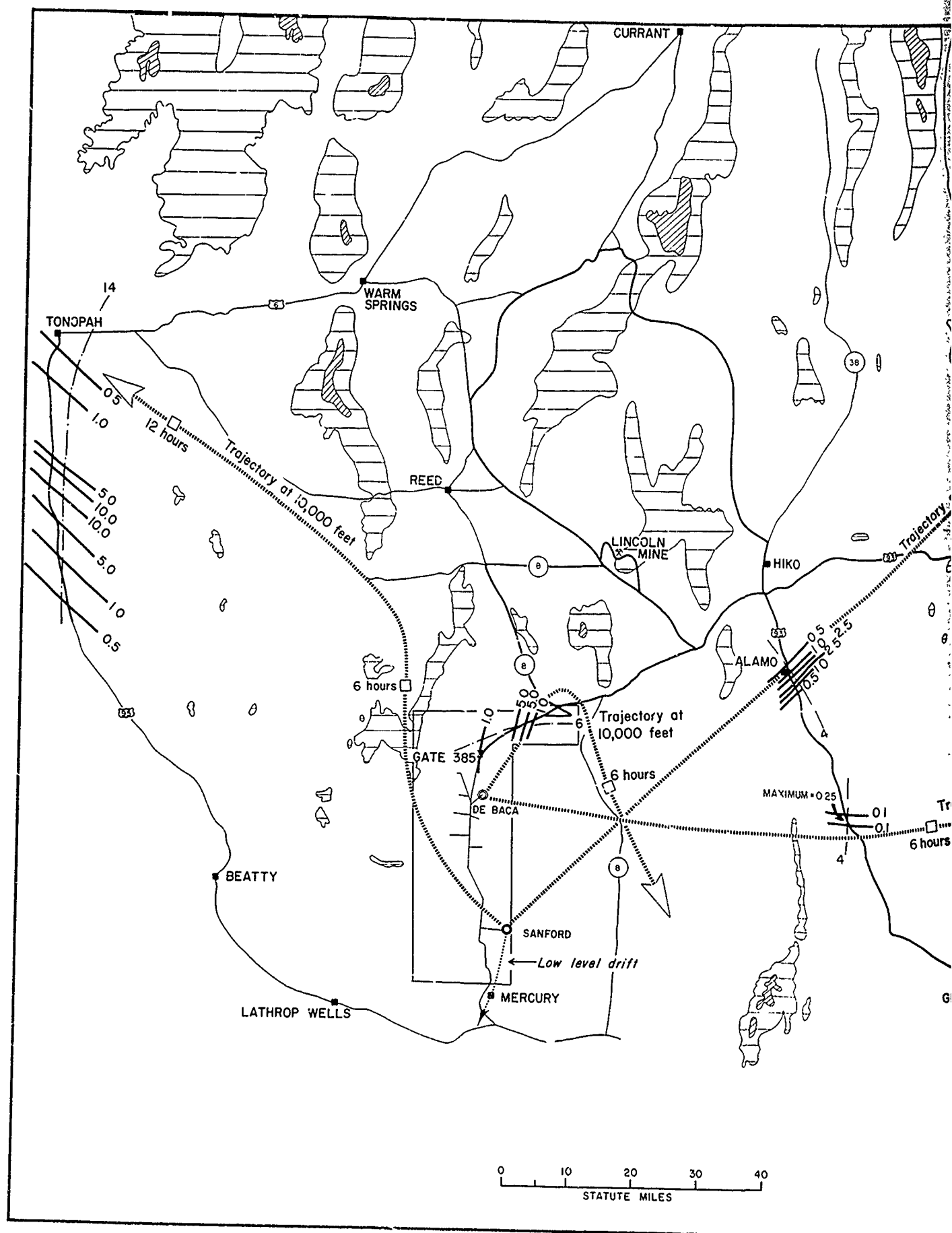
Indications from the on-site data around Area 9 and about 2 miles south-east of ground zero are that the cloud sheared and travelled in two different directions. The readings at these two locations were taken at very early times and were in all probability due to shine. Between these two areas, that is, in the northeast quadrant, activity recorded was very low. Because of the lack of data in most areas around ground zero there is not a very high degree of confidence in this pattern.

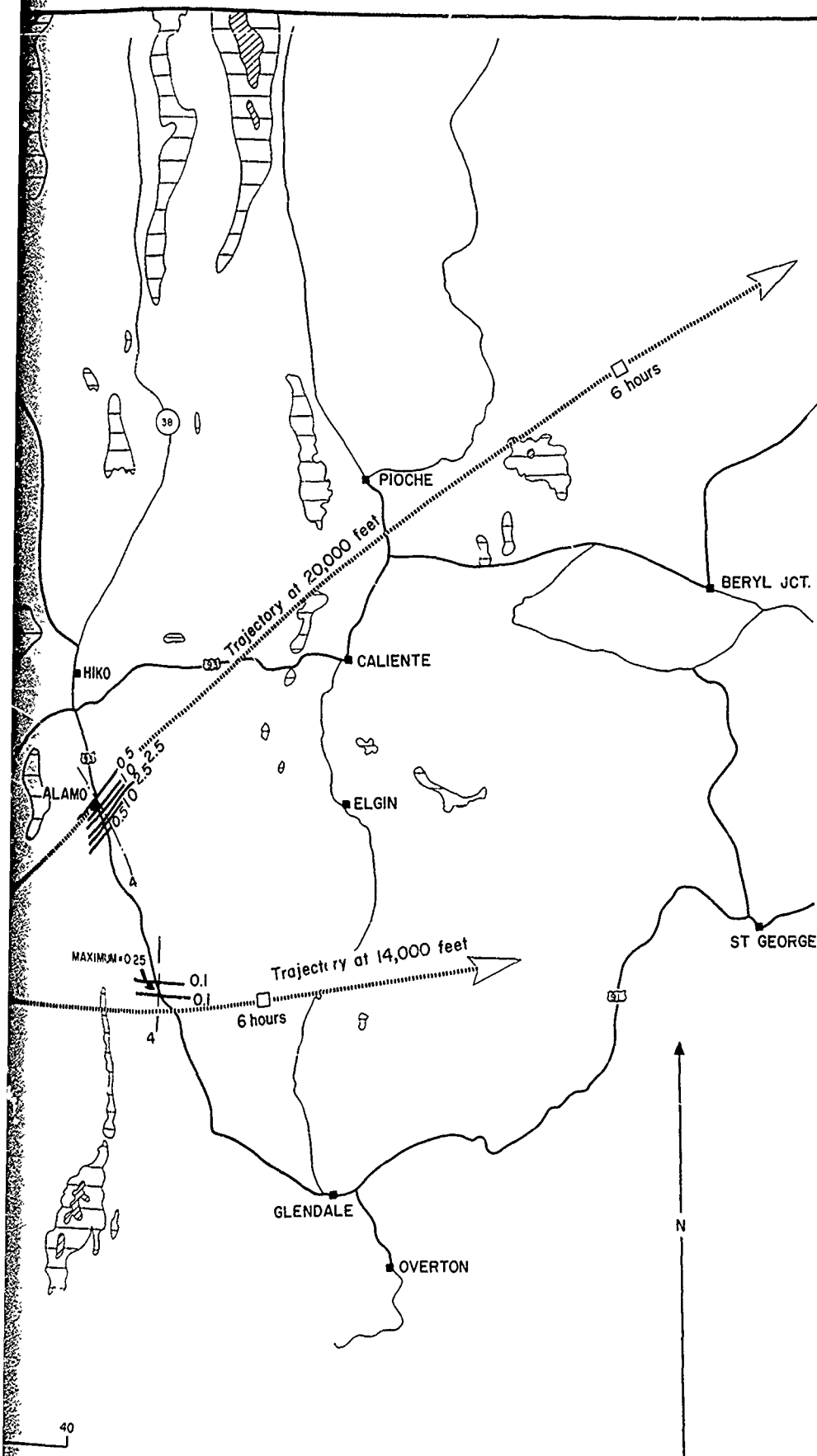
DE BACA (1500 FT. BALLOON) MAP A
H-HR=0800 PST 26 OCT. 1958
CLOUD TOP- 17,500 FT. M.S.L.

RESIDUAL GAMMA RADIATION
MR/HR AT H+1 HOUR

- LEGEND -

— DOSE RATE CONTOURS, MEASURED
- - - DOSE RATE CONTOURS, ESTIMATED



**Sanford****REMARKS**

Activity along Highway 93 just south of Tonopah was attributed to the Sanford event. From the wind analysis it is evident that this activity must have originated from about 14,000 feet m.s.l. or less, while the activity found around the Alamo area and attributed to Sanford must have originated from 18,000 to 26,000 feet m.s.l.

The portion of the cloud that had a trajectory toward the northeast should have crossed the Hiko-Caliente-Pioche-Beryl Junction roads. No activity above background was found along these roads, which would suggest that no activity fell across these roads, that the activity was extremely light and decayed to almost nothing by the time the roads were monitored, or that the fallout, if any, occurred more toward the east. No activity above background was detected north of St. George, however, so that curving toward the east is considered unlikely.

Monitoring and air-sampling data indicated that radioactivity from Sanford passed over Mercury. No estimate of the decay rate could be determined, due to the large fluctuations in the dose rates. Since the winds in the lower layers were from the north, it seems likely that some of the dust raised by the burst in Frenchman Flat drifted past Mercury. The radiation detected was probably due to neutron-induced radioactivity in the Frenchman Flat soil.

De Baca**REMARKS**

Activity that was found from Gate 385 to Road "B" and also south of Alamo along U. S. 93 was attributed to De Baca. The activity to the north most likely originated from about 10,000 feet m.s.l. or less in the nuclear cloud while the activity to the east most likely came from about 12,000 to 17,000 feet m.s.l.

The 14,000 foot De Baca trajectory at the winds above this elevation indicated that the cloud was over U. S. 93 at about the time that fallout was estimated to have arrived (about 4 hours after burst time). The estimate of the trajectory speed may be in error and what was observed may have been either true fallout, or shine. Since there was only one survey along this road for the De Baca event, it is not certain which of the two explanations is the correct one.

No activity above background levels was found from St. George to Glendale, indicating that if any fallout occurred in this direction it was so light that it was not distinguishable from background radiation. The wind analysis showed that it was unlikely that the fallout could have curved to the north, that is, between Hiko and Beryl Junction. The monitors surveyed this road for Sanford, and not for De Baca. It is not known for certain, therefore, if fallout did occur across this road.

SANFORD (1500 FT BALLOON) MAP B

H-HR= 0220 PST 26 OCT. 1958

CLOUD TOP- 26,000 FT. M.S.L.

DE BACA (1500 FT BALLOON) MAP B

H-HR= 0800 PST 26 OCT 1958

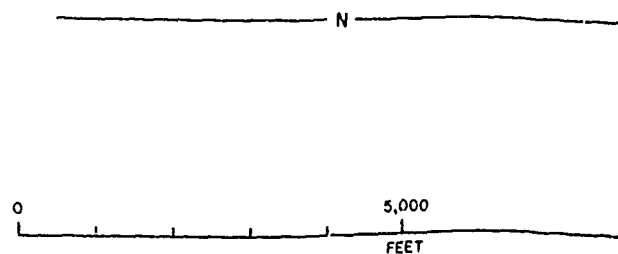
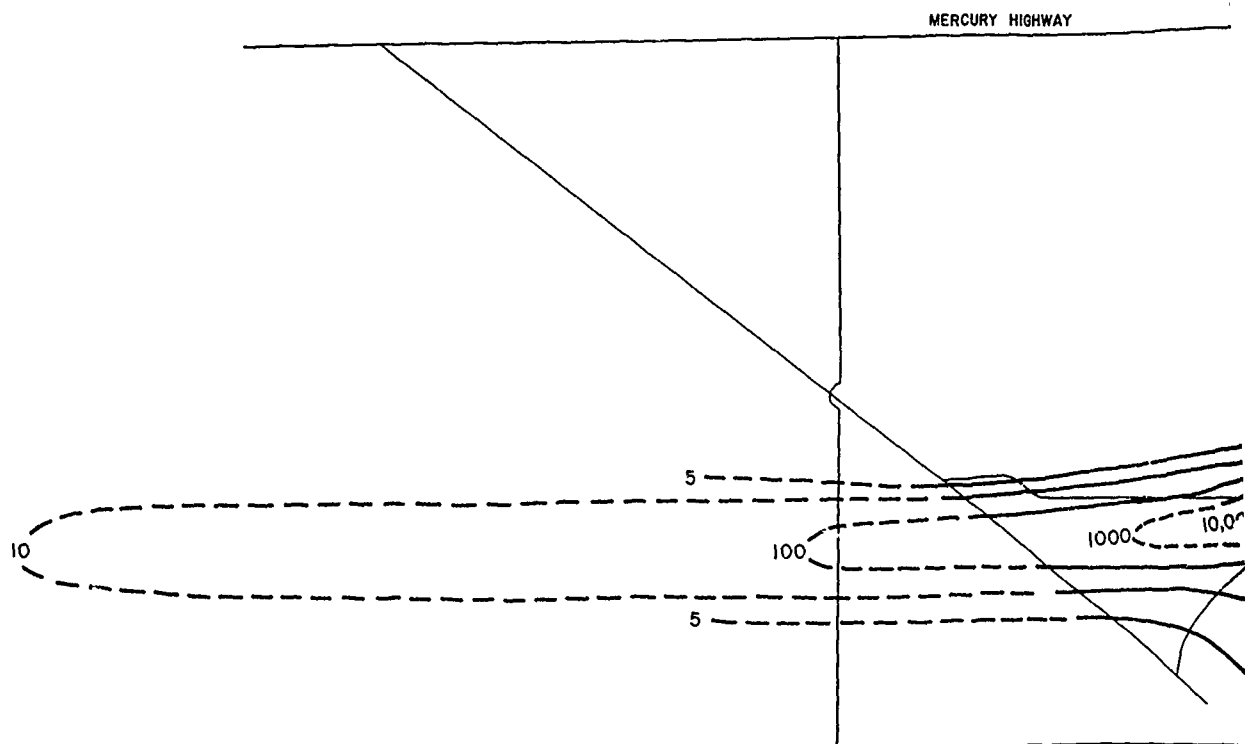
CLOUD TOP- 17,500 FT. M.S.L.

RESIDUAL GAMMA RADIATION

MR/HR AT H+1 HOUR

- LEGEND -

- DOSE RATE CONTOURS, MEASURED
- DOSE RATE CONTOURS, ESTIMATED
- - - - TIME OF ARRIVAL, ESTIMATED, H+HOURS
- ELEVATION 7000 TO 9000 FEET
- ELEVATION MORE THAN 9000 FEET
- ROAD (THICK LINE INDICATES MONITORED SECTION)



MERCURY HIGHWAY

BJY

REMARKS

The downwind extent of the activity isolines can only be a rough approximation because of the limited number of measurements. The rest of the pattern was relatively well documented and should be fairly reliable.

MAXIMUM AT GZ ~80R/HR AT H+1

1000

10,000

T-3

E 690,000

N 840,000

CHAVES (52 1/2 FT WOOD TOWER) MAP A

H-HR= 0630 PST 27 OCT. 1958

CLOUD TOP- 6,500 FT. M.S.L.

RESIDUAL GAMMA RADIATION
MR/HR AT H+1 HOUR

- LEGEND -

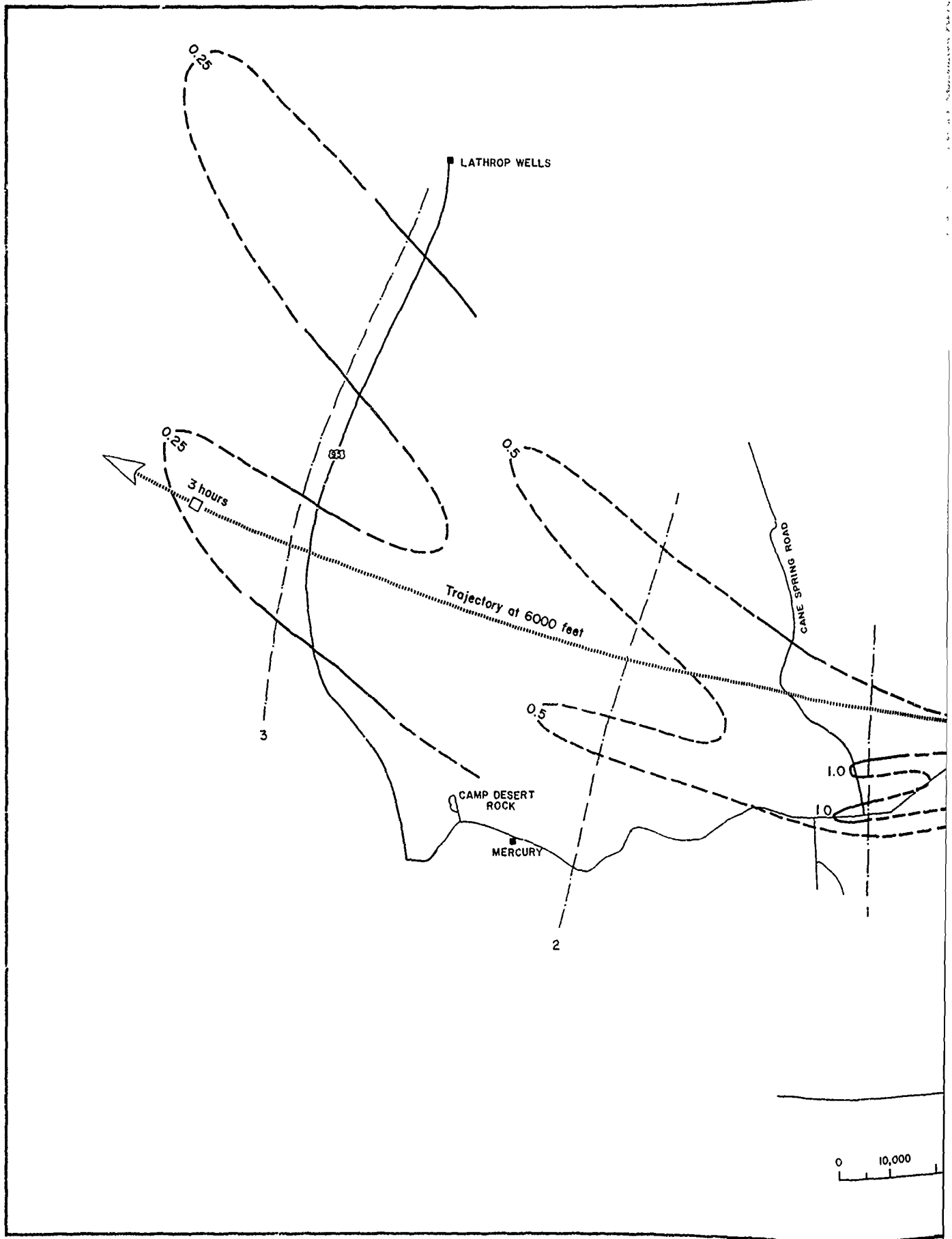
———— DOSE RATE CONTOURS, MEASURED
----- DOSE RATE CONTOURS, ESTIMATED

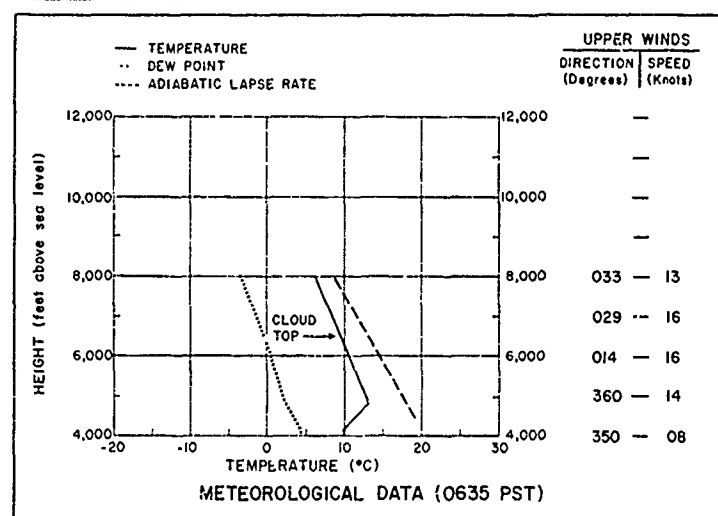
5,000

10,000

FEET

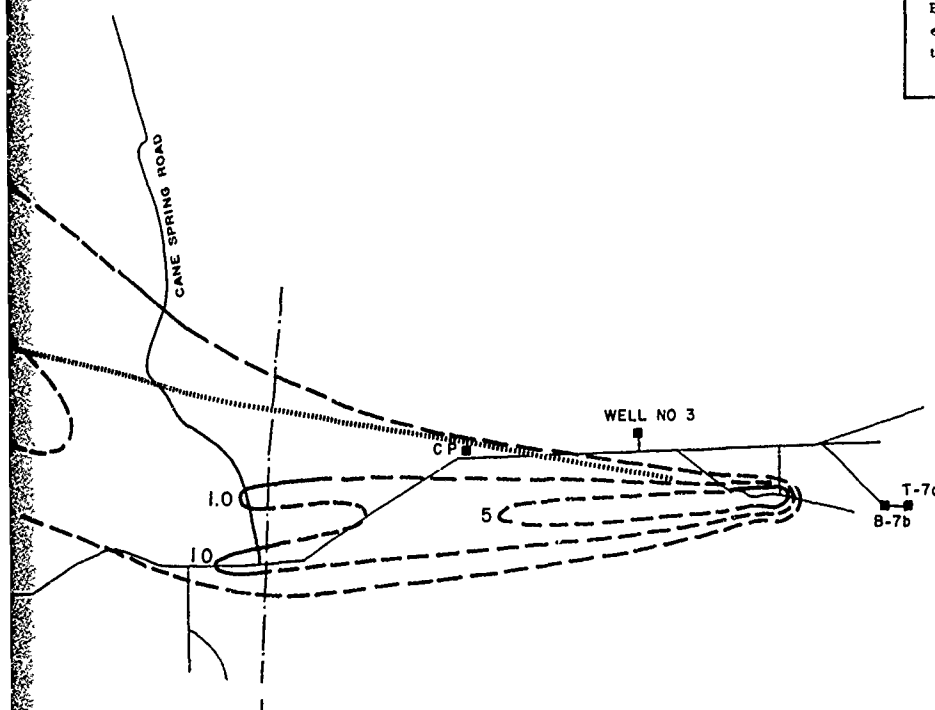
2





REMARKS

Because of the limited area that was and could be monitored the downwind extents of the various isolines are rough approximations, but their orientation, at least, is consistent with the wind analysis.

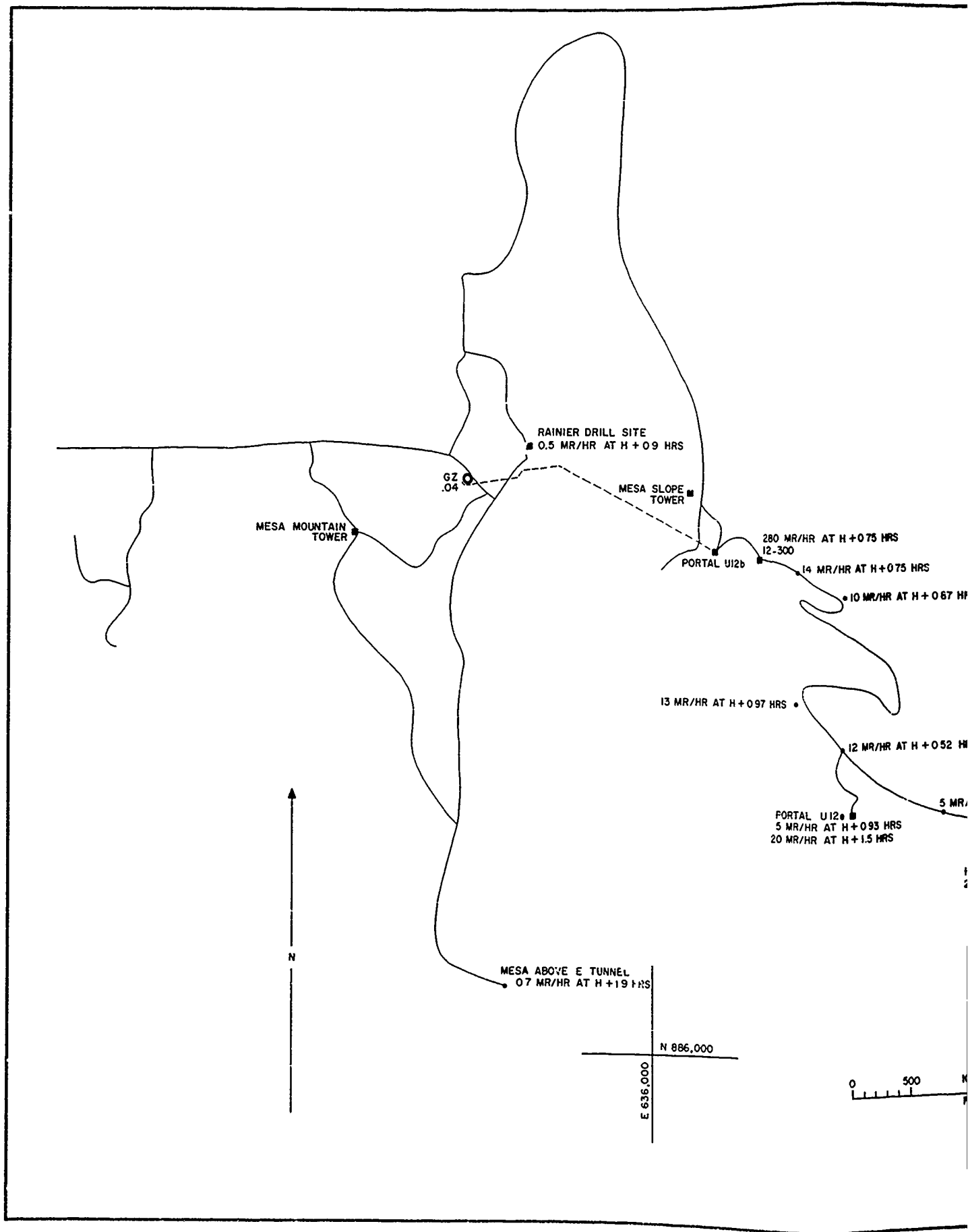


CHAVES (52 1/2 FT WOOD TOWER) MAP B
 H-HR= 0630 PST 27 OCT. 1958
 CLOUD TOP- 3,500 FT M.S.L.

RESIDUAL GAMMA RADIATION
 MR/HR AT H + 1 HGUR

- LEGEND -

———— DOSE RATE CONTOURS, MEASURED
 - - - - DOSE RATE CONTOURS, ESTIMATED



REMARKS

Although there was no organized cloud from the Evans burst, a small amount of smoke was seen to vent from the portal, on the mesa slope at an elevation of about 6,650 feet.

Since the winds at the mesa slope tower were from the west, the vented material should have been transported toward the east or possibly toward the southeast because of the channelling effect of the canyon between the "B" and "E" portals.

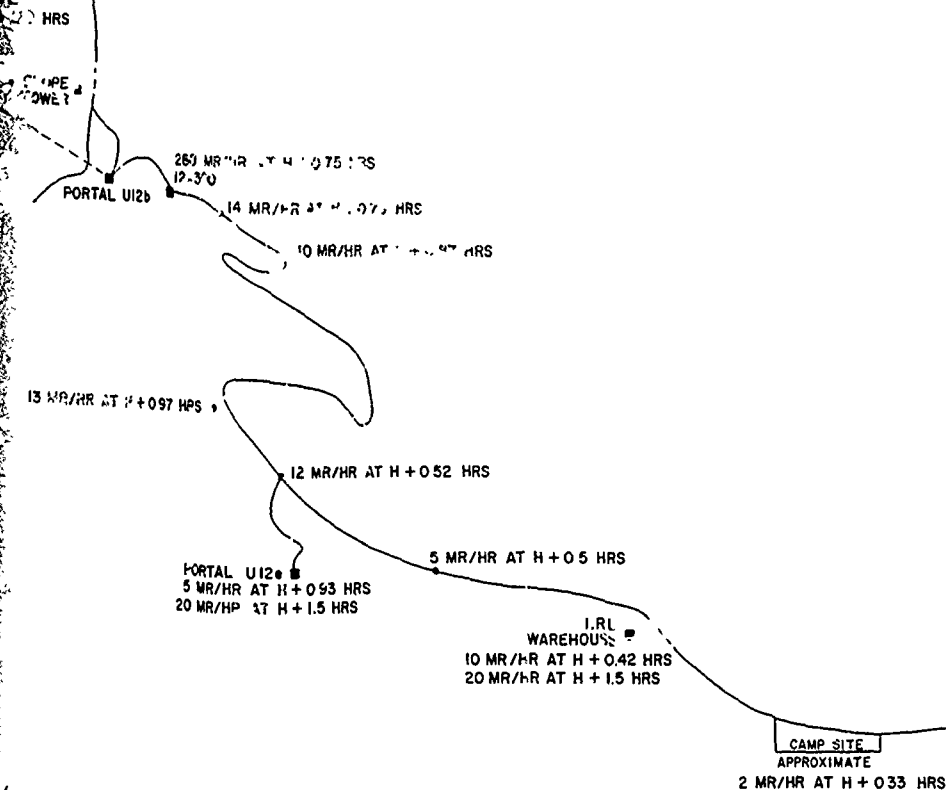
There were two monitoring reports at the LRL Warehouse. 10 mr/hr at 0.42 hours and 20 mr/hr at 1.5 hours after the burst. Also, at the portal of Tunnel U12e there were readings of 5 mr/hr at 0.93 hours and 20 mr/hr at 1.5 hours after the burst. The radiation at these sites cannot logically be attributed to any previous burst. Since after these early surveys there was no further monitoring reported until after the Blanca burst, it is not possible to say whether this radiation was due to airborne debris or due to true fallout. There is a suggestion, however, that the greater part was from airborne material.

The reading at the Rainier Drill Site is believed to be from residual contamination from Neptune. It is uncertain whether the activity on the mesa above the "E" tunnel is residual or from Evans.

15-Minute Average Winds

9 foot Mesa Slope Tower 100 foot Mesa Mountain Tower
(Surface Elevation-6725 feet m.s.l.) (Surface Elevation-7465 feet m.s.l.)

Time (PST)	Direction (degrees)	Speed (m.p.h.)	Direction (degrees)	Speed (m.p.h.)
1445-1500	290	07	010	Missing
1545-1600	290	08	360	Missing
1645-1700	280	08	360	Missing
1745-1800	280	05	360	Missing



EVANS (TUNNEL) MAP A

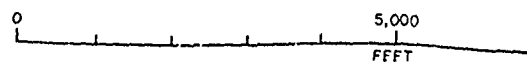
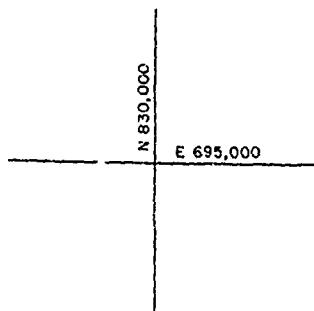
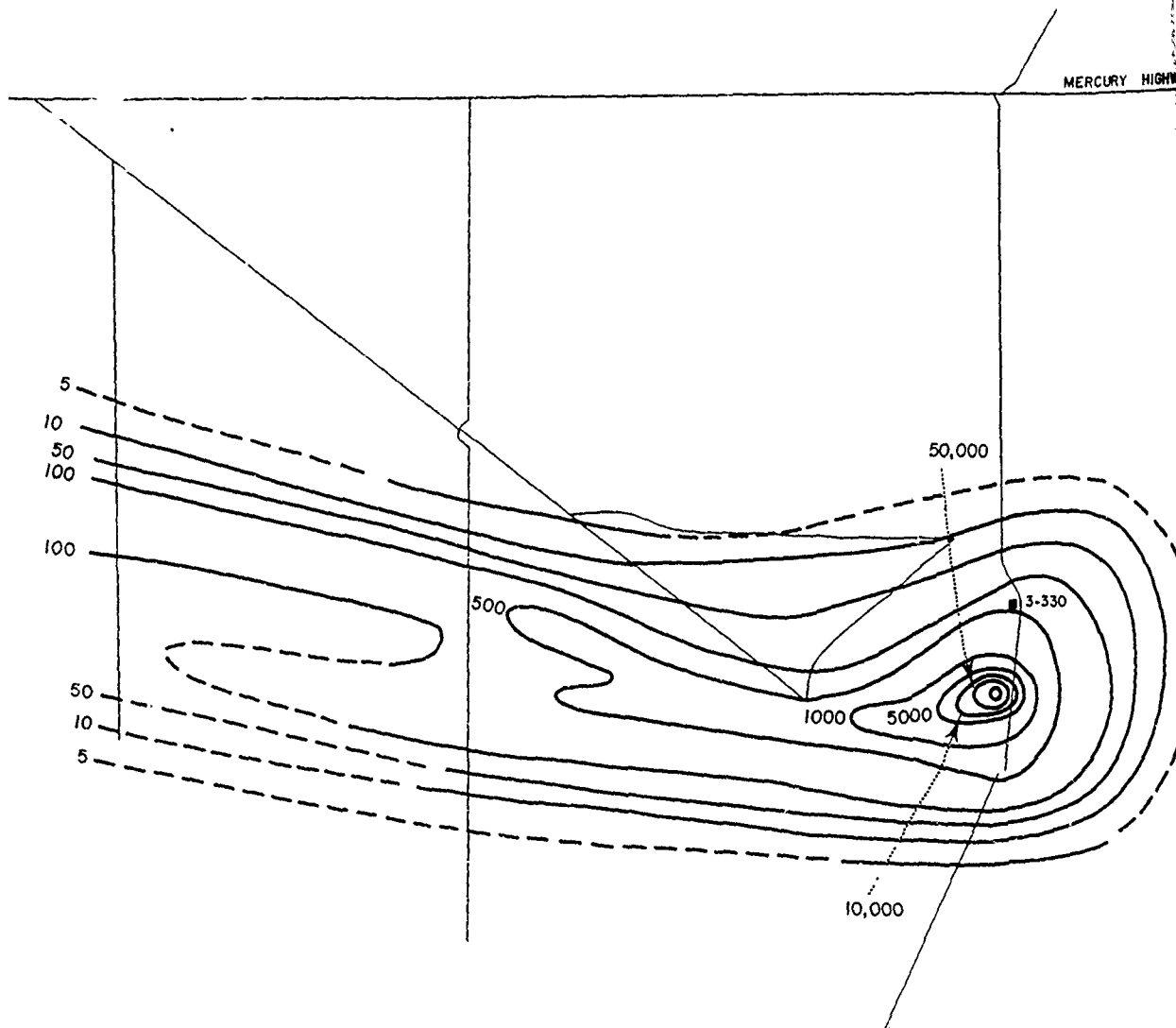
H-HR = 1600 PST 28 OCT. 1958

CLOUD TOP - NO ORGANIZED CLOUD

RESIDUAL GAMMA RADIATION
MR/HR AT TIME OF OBSERVATION

- LEGEND -

- DOSE RATE CONTOURS, MEASURED
- - - - DOSE RATE CONTOURS, ESTIMATED



REMARKS

The on-site fallout from Humboldt was well documented and the pattern is considered reliable.

MERCURY HIGHWAY

BJY

50,000

3-330

MAXIMUM AT G.Z ~ 500 R/HR AT H+1

5,000

N

5,000

FEET

10,000

HUMBOLDT (25 FT. WOOD TOWER) MAP A

H-HR= 0645 PST 29 OCT. 1958

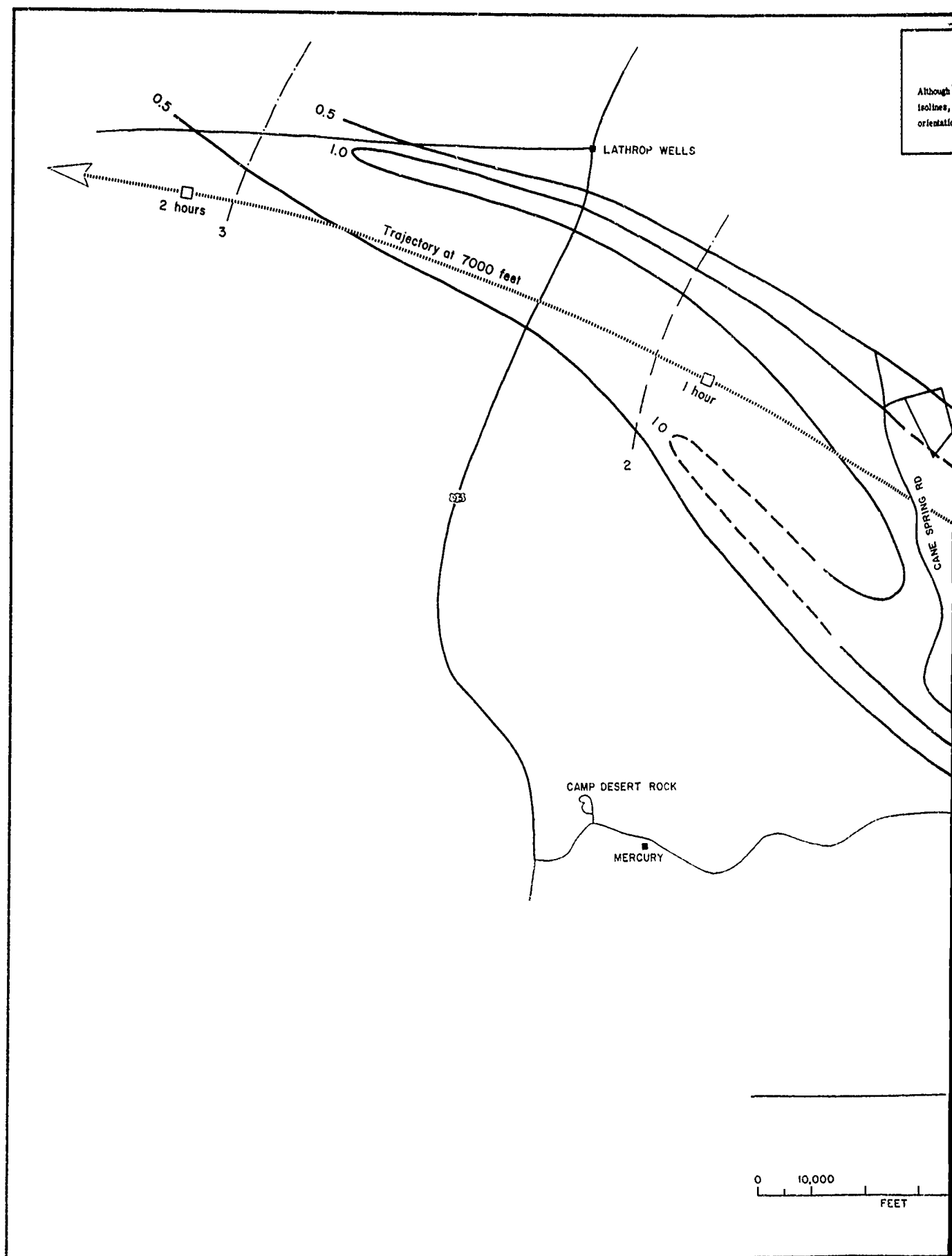
CLOUD TOP- 7,500 FT M.S.L.

RESIDUAL GAMMA RADIATION

MR/HR AT H+1 HOUR

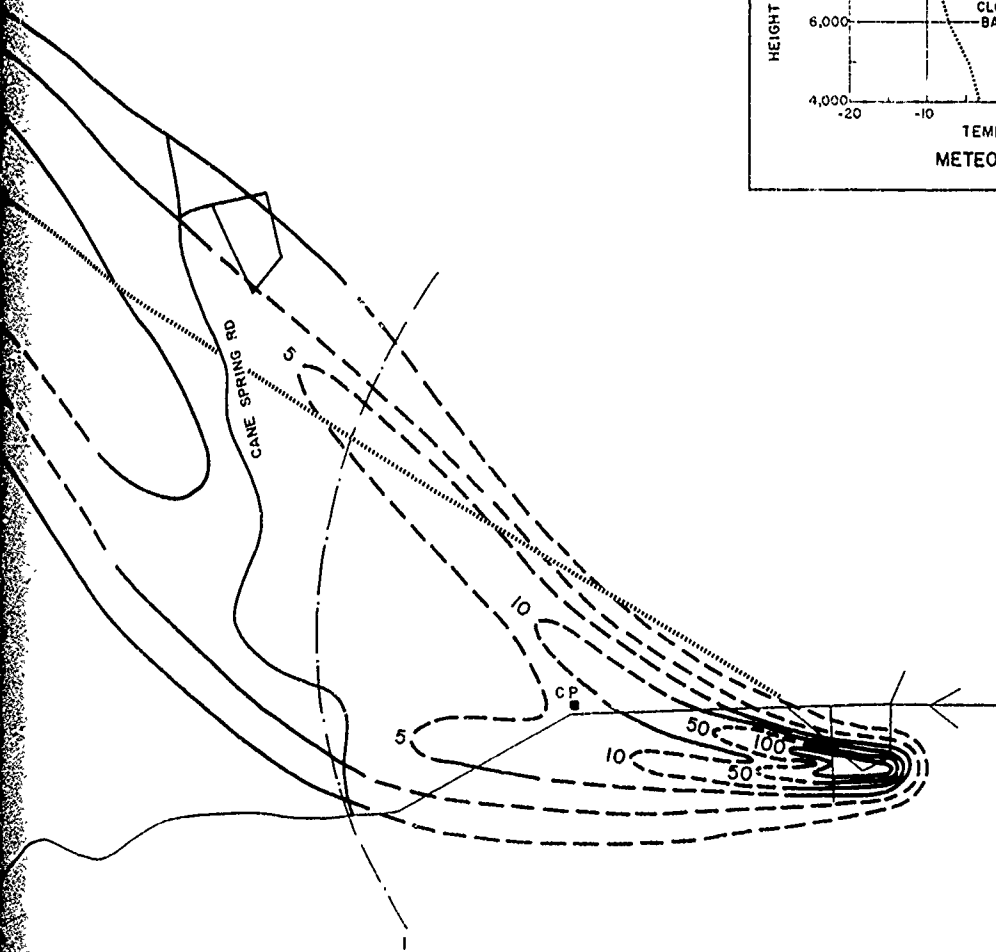
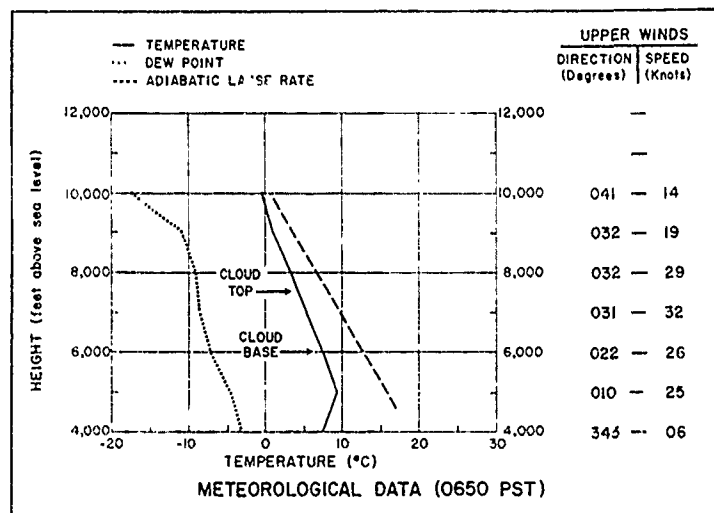
-- LEGEND --

———— DOSE RATE CONTOURS, MEASURED
 - - - - DOSE RATE CONTOURS, ESTIMATED



REMARKS

Although there is some uncertainty in the downwind extent of some of the isolines, there is fair confidence in the width of the pattern and in the orientation of the fallout, which is consistent with the wind analysis.



HUMBOLDT (25 FT WOOD TOWER) MAP B

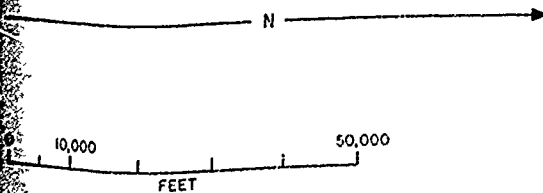
H-HR= 0645 PST 29 OCT. 1958

CLOUD TOP- 7,500 FT. M.S.L

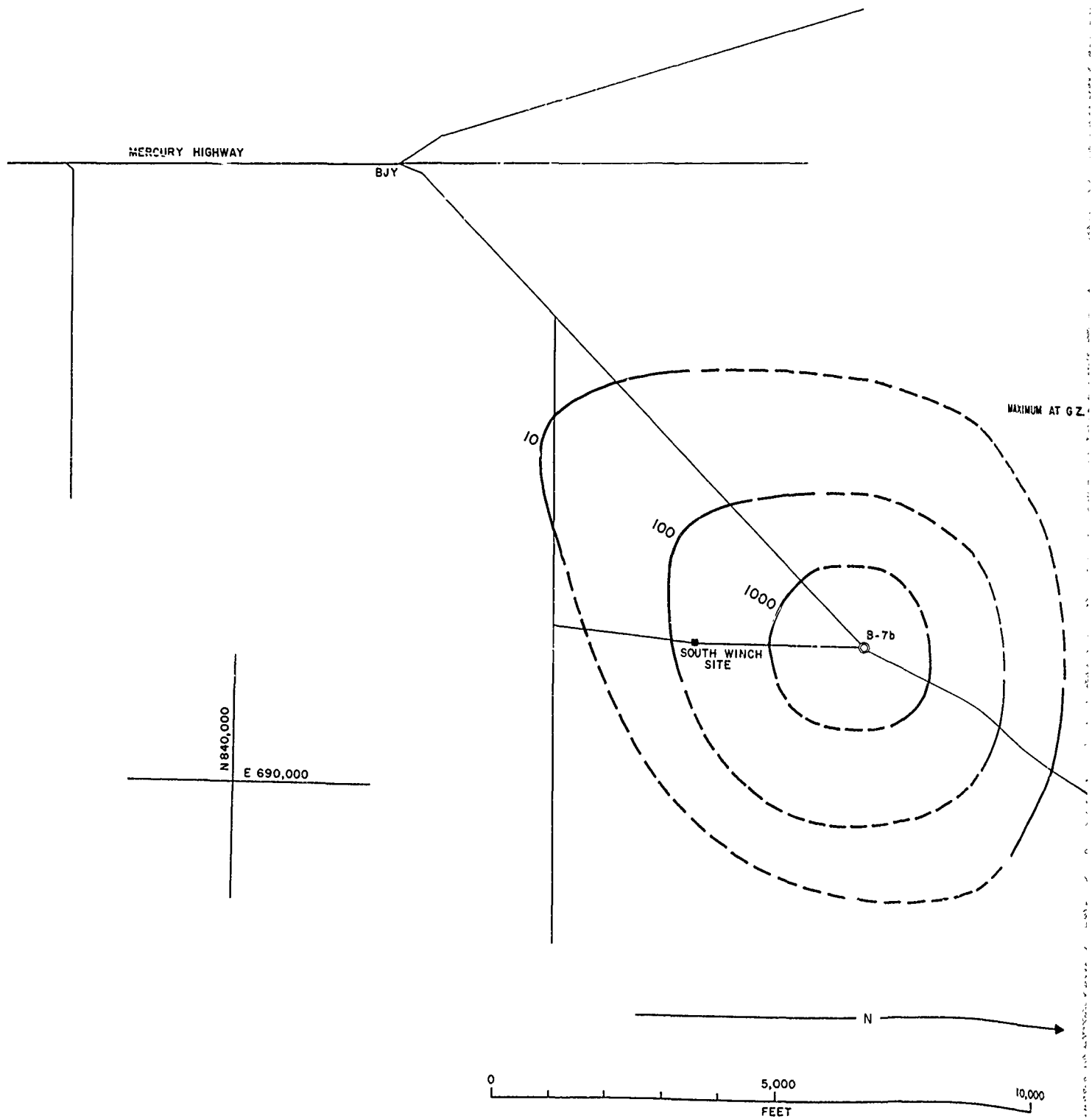
RESIDUAL GAMMA RADIATION
MR/HR AT H+1 HOUR

— LEGEND —

———— DOSE RATE CONTOURS, MEASURED
 - - - - - DOSE RATE CONTOURS, ESTIMATED

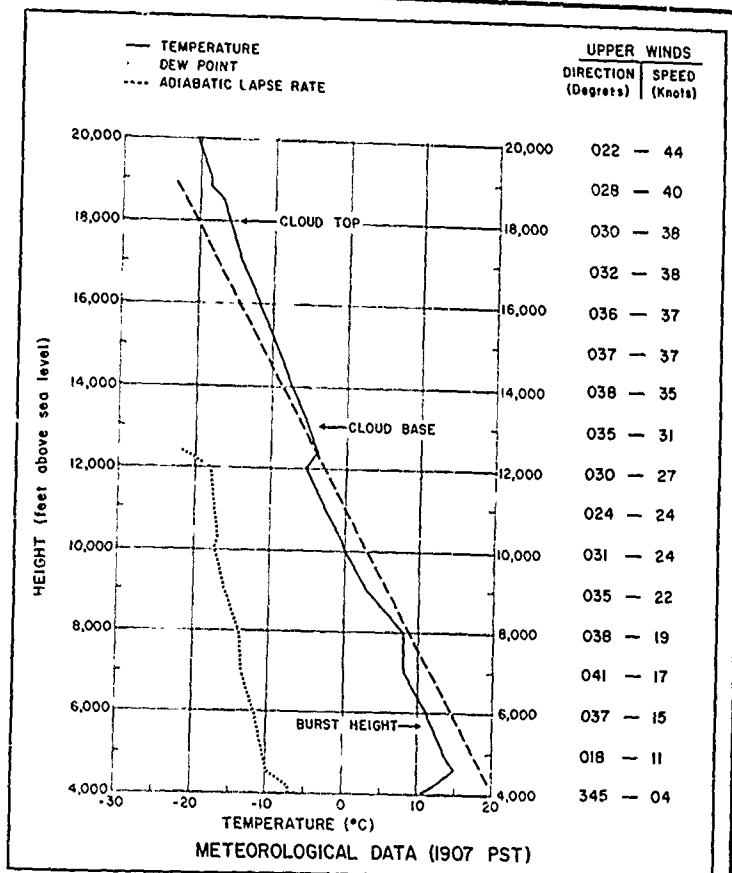


REMARKS
The intensity of site was relatively
should be fairly reliable



REMARKS

The instrumentation on site was relatively well monitored and the pattern should be fairly reliable.



MAXIMUM AT GZ ~ 5 R/HR AT H + 1

B-7b

N

10,000

SANTA FE (1500 FT. BALLOON) MAP A

H-HR = 1900 PST 29 OCT. 1958

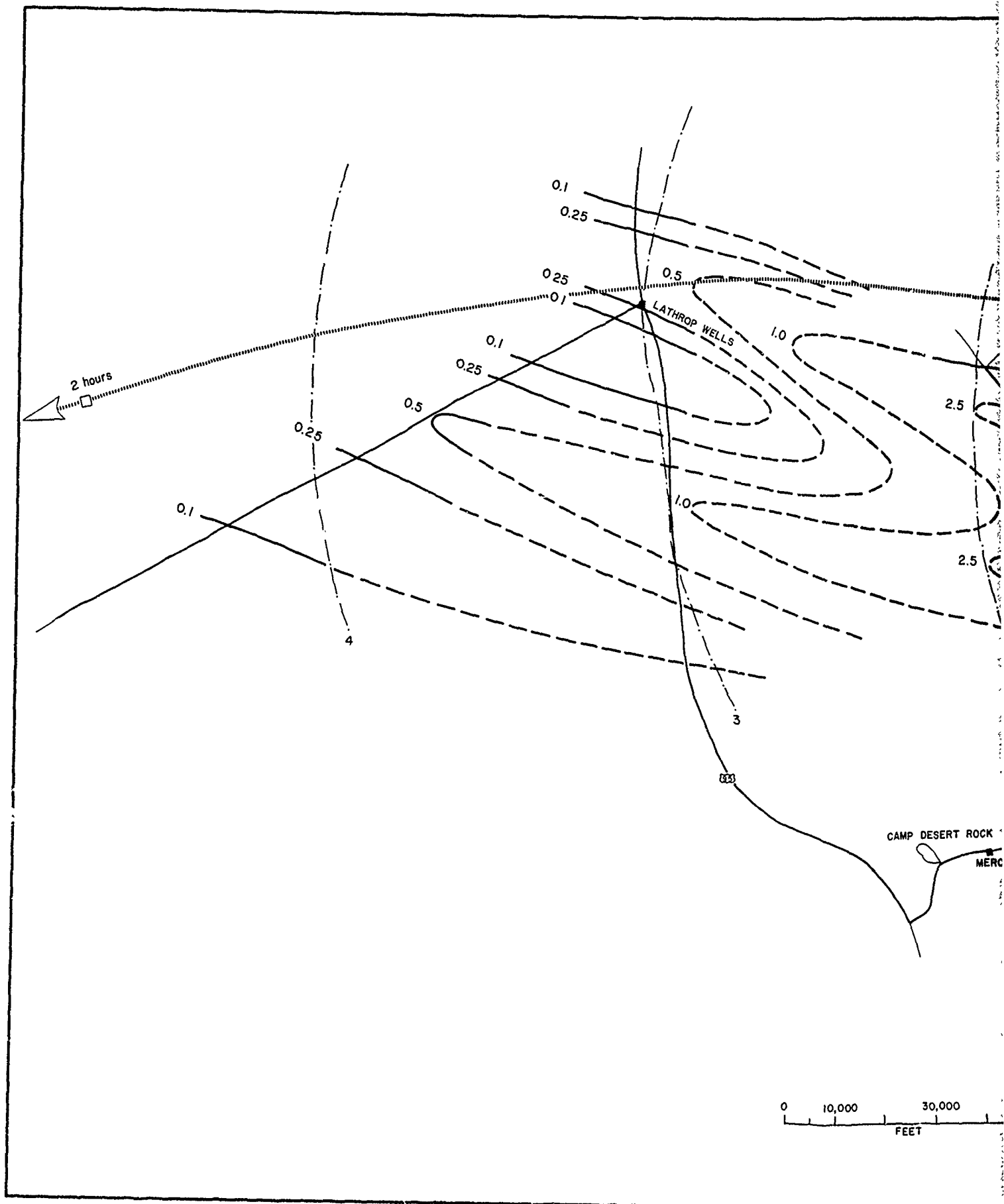
CLOUD TOP = 18,000 FT. M.S.L.

RESIDUAL GAMMA RADIATION

MR/HR AT H + 1 HOUR

— LEGEND —

— DOSE RATE CONTOURS, MEASURED
 --- DOSE RATE CONTOURS, ESTIMATED

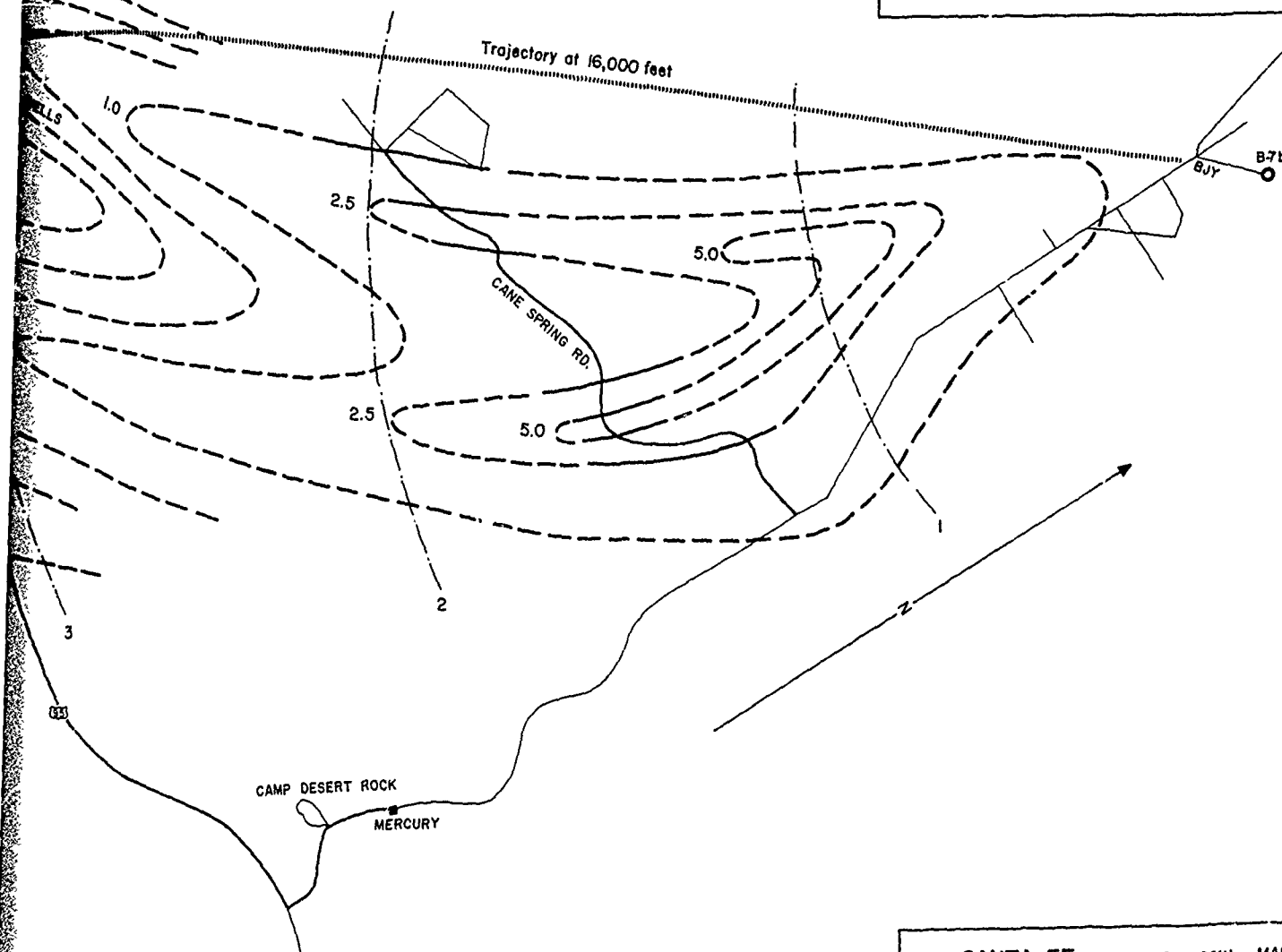


REMARKS

The part of the pattern between the area of induced activity very near the burst site and Cane Spring Road is highly speculative, and it is not known whether or not there was a continuous pattern of very light fallout from the burst area to the Cane Spring Road.

Along Highway 95 from Mercury to about 4 miles east of Lathrop Wells no activity distinguishable from background was observed in a survey made between 1.5 and 2.2 hours after the detonation. It is suspected, however, that the survey was made before fallout arrived. Based on the fallout recorded at Lathrop Wells, the arrival should have been at about 3 hours after the burst.

In general, the off-site pattern is unreliable.



SANTA FE (1500 FT BALLOON) MAP B
H-HR = 1900 PST 29 OCT. 1958
CLOUD TOP - 18,000 FT. M.S.L.

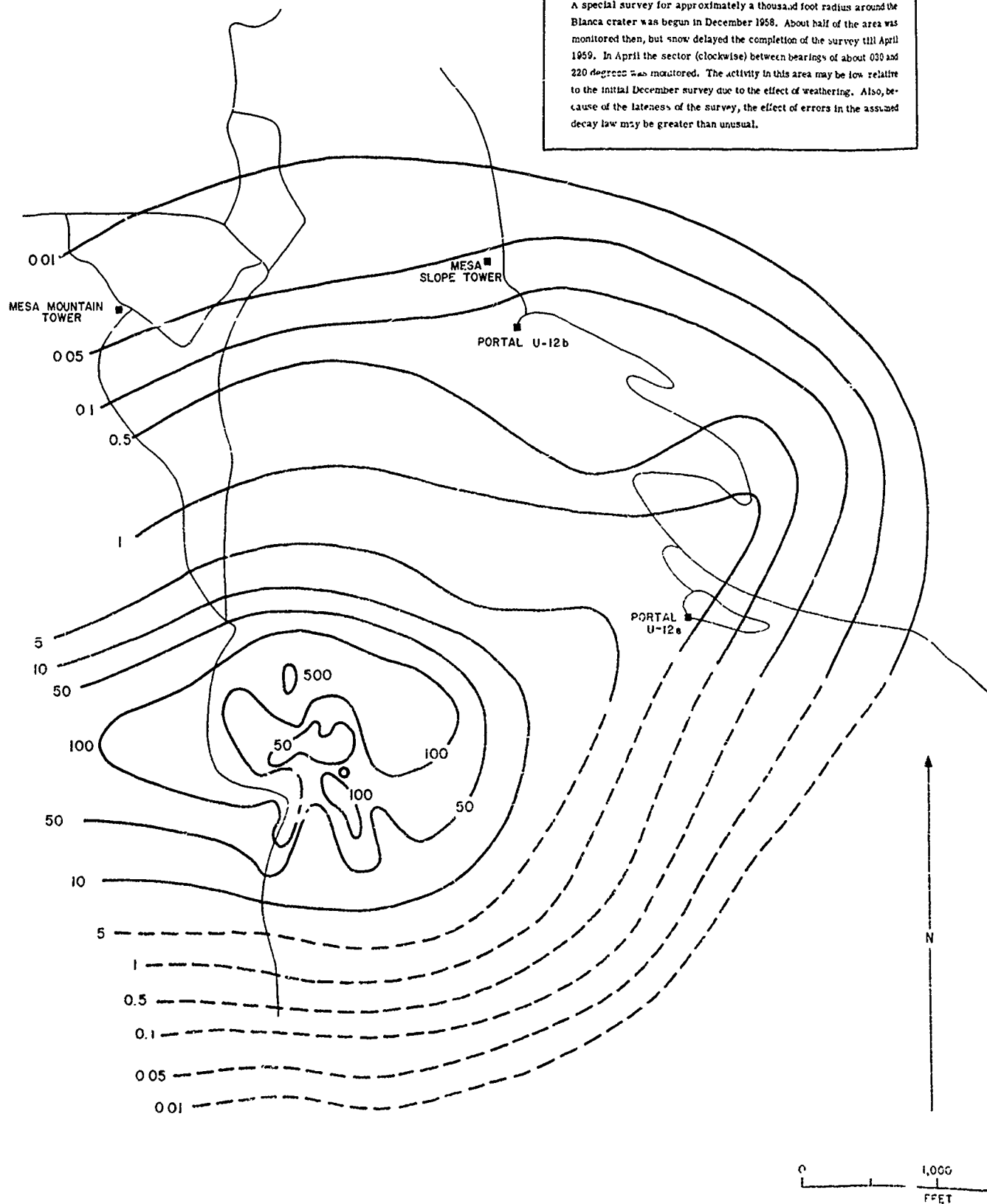
RESIDUAL GAMMA RADIATION
MR/HR AT H+1 HOUR

- LEGEND -

———— DOSE RATE CONTOURS, MEASURED
----- DOSE RATE CONTOURS, ESTIMATED

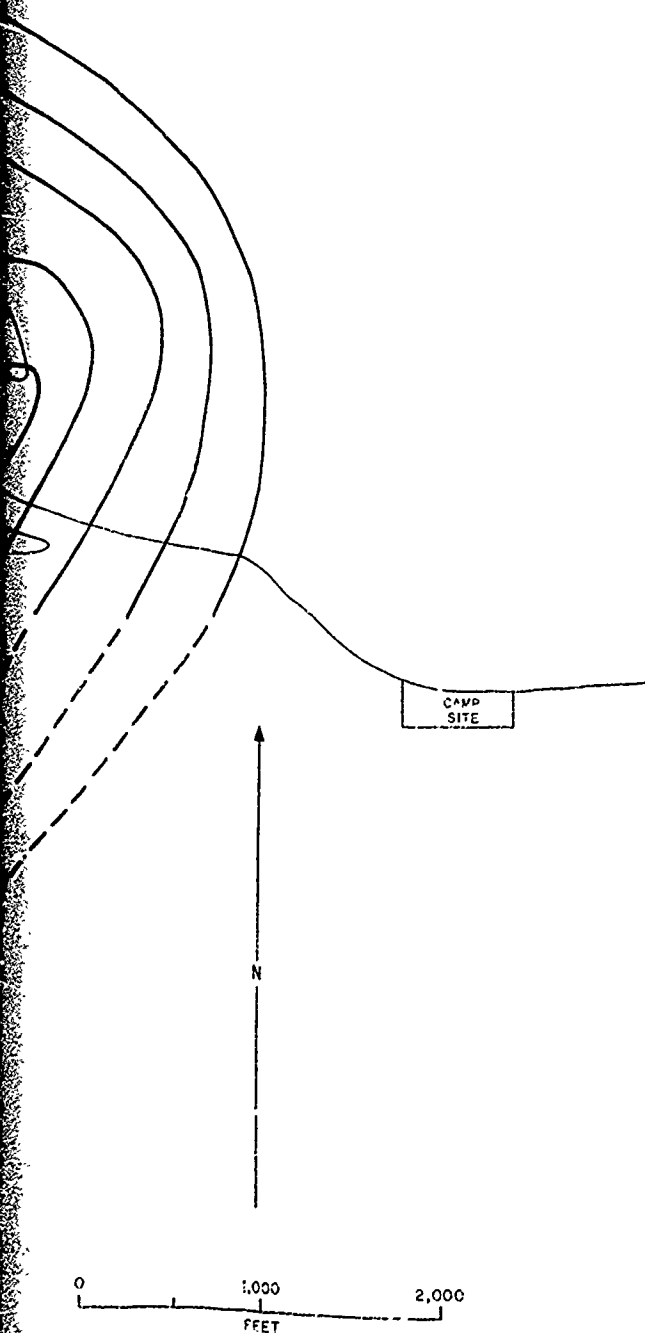
REMARKS

A special survey for approximately a thousand foot radius around the Blanca crater was begun in December 1958. About half of the area was monitored then, but snow delayed the completion of the survey till April 1959. In April the sector (clockwise) between bearings of about 030 and 220 degrees was monitored. The activity in this area may be low relative to the initial December survey due to the effect of weathering. Also, because of the lateness of the survey, the effect of errors in the assumed decay law may be greater than unusual.



MARKS

by a thousand foot radius around the
 1958. About half of the area was
 the completion of the survey till April
 between bearings of about 030 and
 activity in this area may be low relative
 to the effect of weathering. Also, be-
 the effect of errors in the assumed
 usual.



REMARKS

The small-scale on-site map shows three tongues of activity crossing the back road to the mesa also referred to as the Castle Rock Road. This road was monitored shortly after the Blanco detonation and again about 7 months later. Due to inadequate mapping and the scarcity of good reference points, there is considerable uncertainty in the location of the peak or peaks of activity on this road. One of the two teams making the initial surveys reported a peak 0.5 mile south of Castle Rock which would have been about 10 r/hr at H+1. The other team reported a peak 2.0 miles north of Castle Rock of 50 r/hr as of H+1.

When the survey was made 7 months later, reference stakes were available at half-mile intervals along this road, so that the location of the fallout detected is much more certain than in the initial surveys. This late survey indicated three peaks 0.5, 1.5 and 2.8 miles north of Castle Rock. The conversion by the $t^{-1.2}$ approximation would indicate H+1 dose rates respectively of about 1, 1.5 and 5 r/hr. Since this was a careful survey with accurate positioning, three peaks were assumed to have existed at the locations indicated. However, because of the probable reduction in radiation by weathering and the errors probably attendant in assuming a simple decay law to be valid for such a long period, the H+1 dose rates were estimated from the initial survey. It should be noted that there is an order of magnitude discrepancy in the estimation of the H+1 dose rates from the early to late surveys.

With the uncertainties mentioned above and the large areas that could not be monitored between the venting site and the Castle Rock Road and west of this road, there is very little confidence in this pattern.

BLANCA (TUNNEL) MAP A

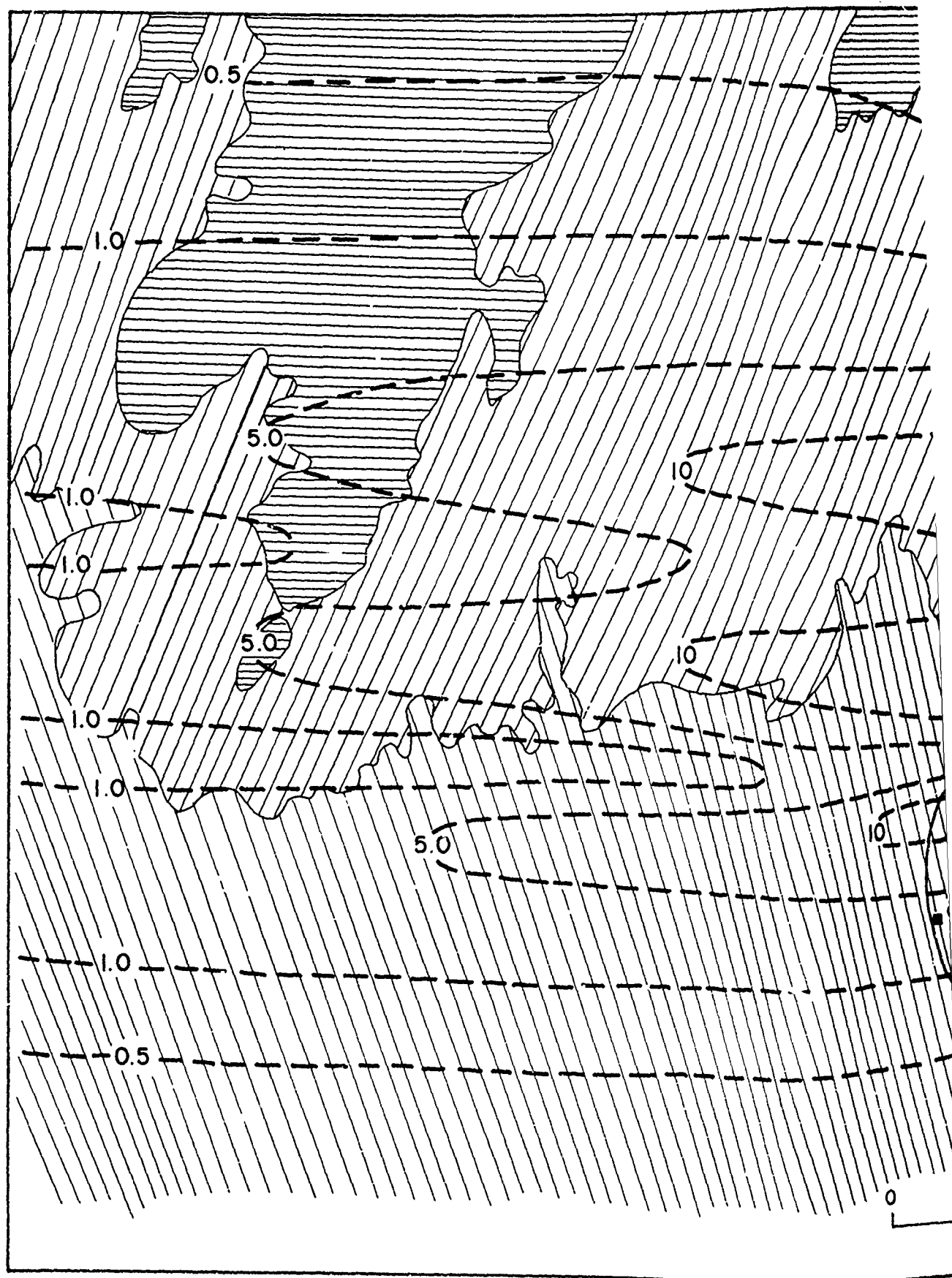
H-HR=0700 PST 30 OCT. 1958

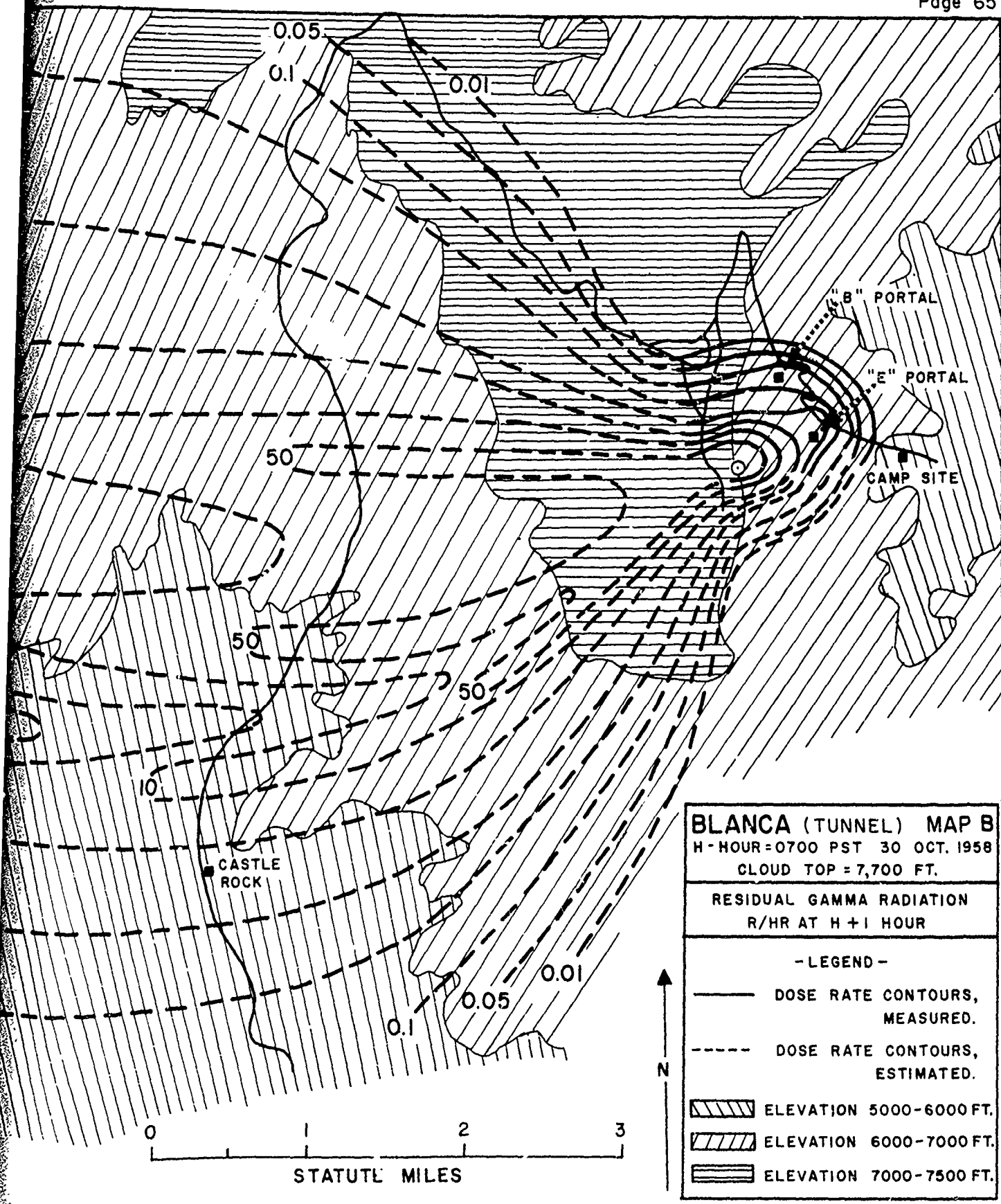
CLOUD TOP-7,700 FT. M.S.L.

RESIDUAL GAMMA RADIATION R/HR AT H+1 HOUR

- LEGEND -

- DOSE RATE CONTOURS, MEASURED
- DOSE RATE CONTOURS, ESTIMATED





BLANCA (TUNNEL) MAP B

H-HOUR = 0700 PST 30 OCT. 1958

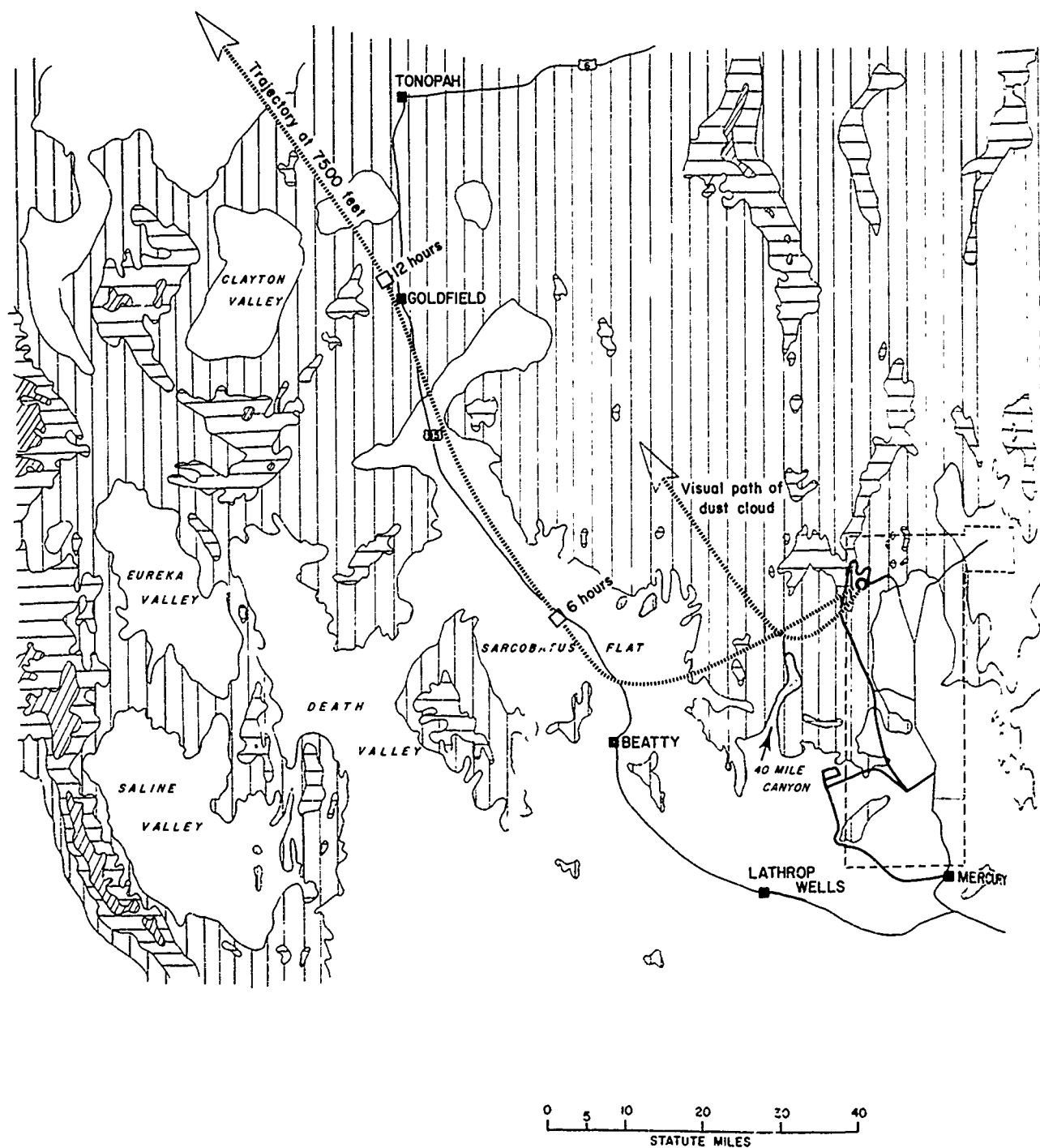
CLOUD TOP = 7,700 FT.

RESIDUAL GAMMA RADIATION
R/HR AT H+1 HOUR

- LEGEND -

- DOSE RATE CONTOURS, MEASURED.
- - - DOSE RATE CONTOURS, ESTIMATED.
- ELEVATION 5000-6000 FT.
- ELEVATION 6000-7000 FT.
- ELEVATION 7000-7500 FT.

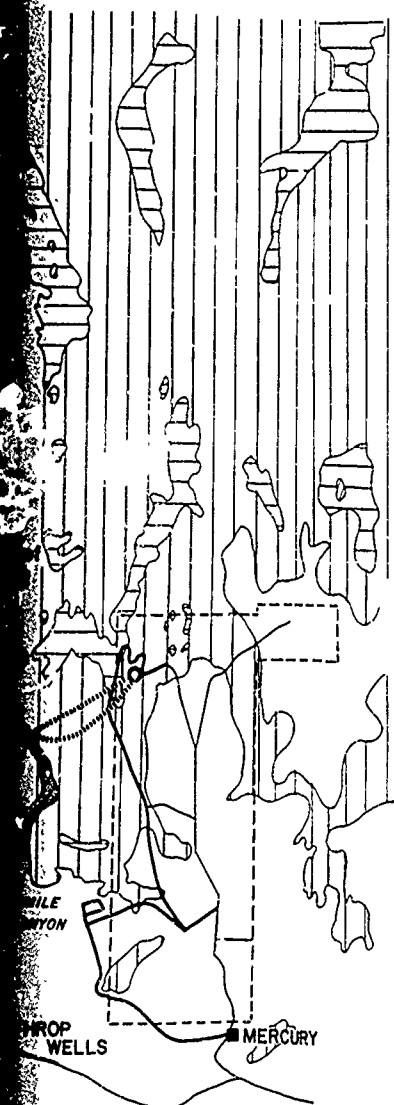
2



REMARKS

The dust cloud from Blanca was observed to be travelling toward the southwest at about ten minutes after the burst. About 30 minutes later it was reported to be travelling up Forty Mile Canyon. The rough trajectory of this dust cloud is indicated on the map. Also shown is the meteorological trajectory for 7,500 feet m.s.l. This trajectory was estimated to have moved initially toward the southwest for about 4 hours and then to have veered northwest-ward over Sarcobatus Flats, toward Tonopah.

Air sampling off-site showed a significant increase in alpha activity at Tonopah, Goldfield, and Beatty, which is attributed to Blanca. The beta activity measurements showed only a slight increase at these locations. Since the area west of the Test Site along Highway 95 was not monitored except near Lathrop Wells, it is not certain that fallout from Blanca occurred off site; but the alpha measurements, the trajectories, and possibly the beta measurements indicate that some light fallout did occur off site.







BLANCA (TUNNEL) MAP C

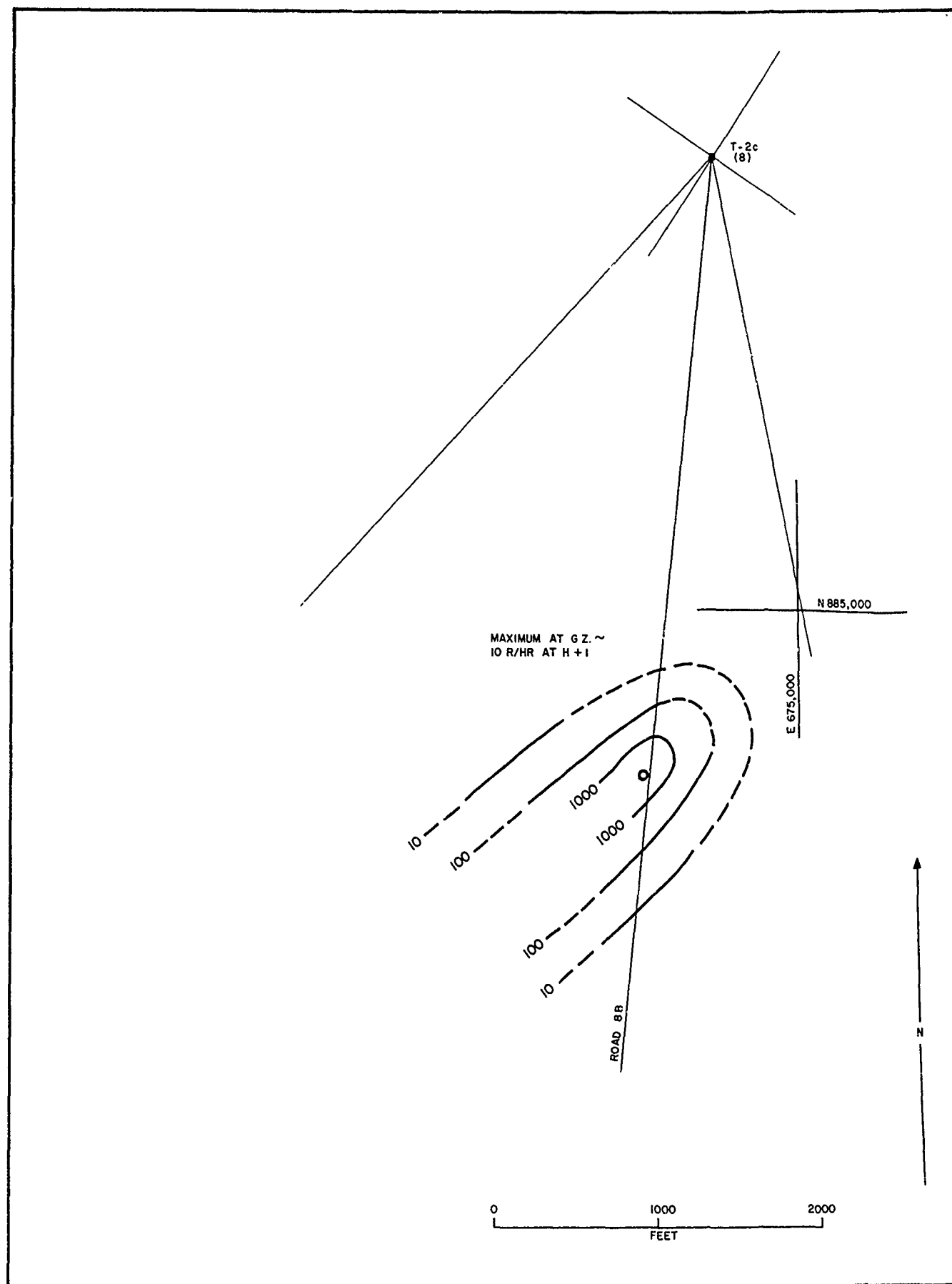
H-HR= 0700 PST 30 OCT. 1958

CLOUD TOP- 7700 FT MSL.

TRAJECTORY MAP

- LEGEND -

-  ELEVATION 5000 TO 7000 FEET
-  ELEVATION 7000 TO 9000 FEET
-  ELEVATION MORE THAN 9000 FEET
-  ROAD (THICK LINE INDICATES MONITORED SECTION)



REMARKS

There was a trivial yield from Titania and a cloud height of about 6,000 feet m.s.l. was observed (a rise of about 1,500 feet). The only available meteorological data at about shot time were the wind observations at Yucca Lake (about 15 miles south of the burst point) and at Station 353 (about 2-1/2 miles south of the burst point on Road 8B). Based on these observations the pattern has been oriented toward the southwest and the isoline left open in the southwest quadrant.

No off-site contamination was detected.

Upper Winds at Yucca Lake Weather Station

(Elevation 3924 feet m.s.l.)

Observation at 1257 PST

Height (m.s.l.)	Direction (degrees)	Speed (knots)
4,000	080	08
5,000	060	13
6,000	060	13
7,000	080	12
8,000	070	11

15-Minute Average Winds

20-foot Tower at Station 353

(Surface Elevation About 4325 feet m.s.l.)

Time (PST)	Direction (degrees)	Speed (m.p.h.)
1045-1100	045	14
1145-1200	075	13
1245-1300	075	12
1345-1400	085	11

TITANIA (25 FT. WOOD TOWER) MAP A

H-HR=1234 PST 30 OCT. 1958

CLOUD TOP- 6000 FT. M.S.L.

RESIDUAL GAMMA RADIATION

MR/HR AT H + 1 HOUR

- LEGEND -

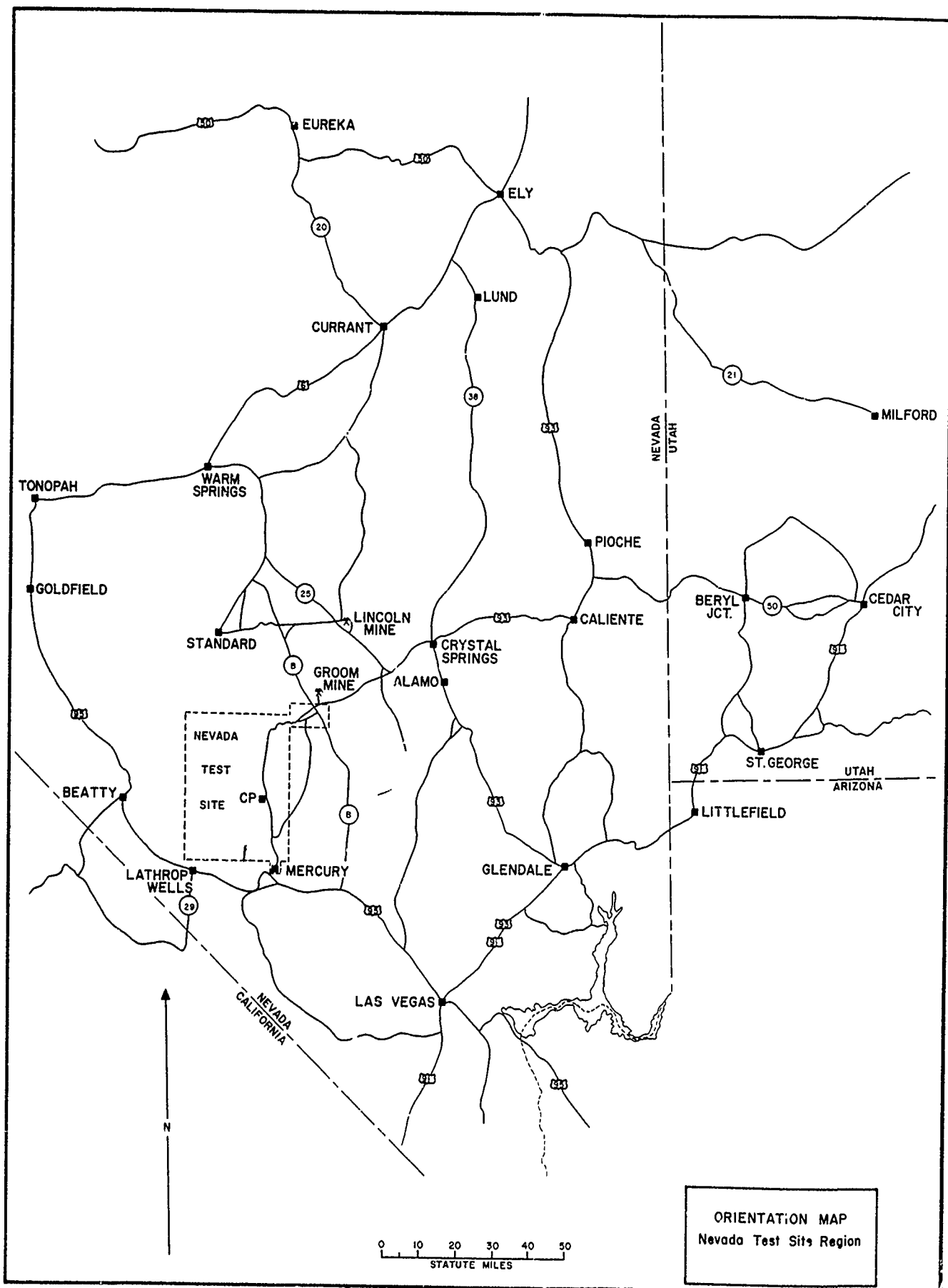
———— DOSE RATE CONTOURS, MEASURED
 - - - - - DOSE RATE CONTOURS, ESTIMATED

N 085,000

N

2000

2



ION MAP
Site Region

